170116

K.7
2/13/84

HYDROGEOLOGIC STUDY
TECHNICAL MEMORANDUM

ECC SITE
ZIONSVILLE, INDIANA

EPA 18.5L30.0
W65230.C3

FEBRUARY 13, 1984

CONTENTS

FIGURES

TABLES

MEMORANDUM

TO: File

FROM: Dennis E. Totzke/CH2M HILL/GLO

DATE: February 13, 1984

SUBJECT: ECC Remedial Investigation
Hydrogeologic Investigation
Subtask 3-1

JOB NO: W65230.C3

INTRODUCTION

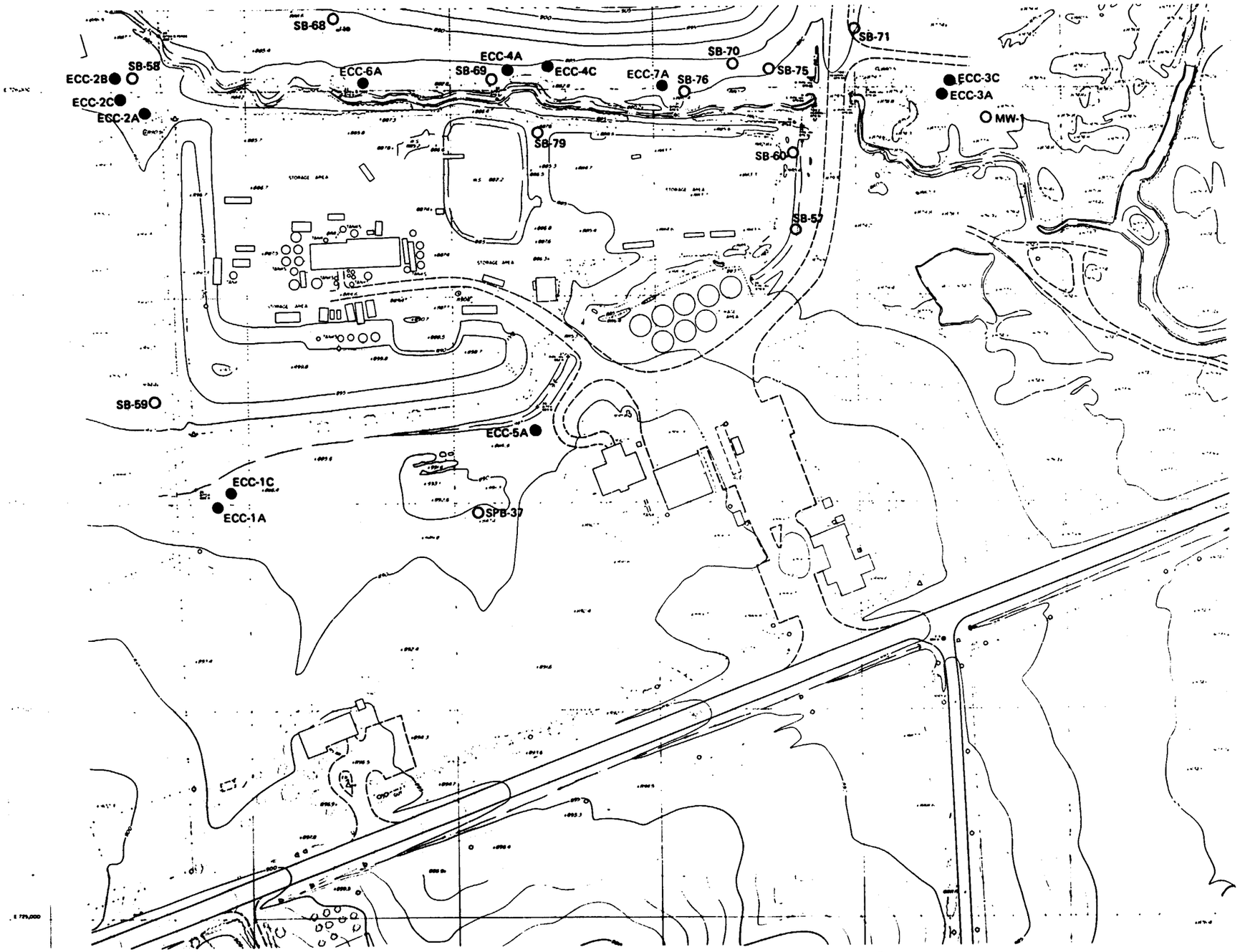
This document is a Hydrogeologic Study technical memorandum (TM) for the Environmental Chemical and Conservation Corporation (ECC) site near Zionsville, Indiana. This work was performed in partial satisfaction of Contract No. 68-01-6692, Work Assignment No. 18.5L70.0, Task 3-1 of the Remedial Investigation authorized by the U.S. EPA. The primary purpose of the TM is to provide documentation of data obtained during the drilling and installation of groundwater monitoring wells.

PROBLEM STATEMENT

Environmental Chemical and Conservation Corp. operated as a solvent processing and reclaiming facility from 1977 until May 1980. During this period, approximately 350 generators disposed of such wastes as resins, paint sludges, waste oils and flammable solvents onsite in 55-gallon drums or by bulk discharge to onsite storage tanks. Some of the solvent wastes were processed and recovered. The site was closed down in early 1982 with an outstanding waste inventory of over 25,000 drums of liquid and solid wastes, and about 300,000 gallons of bulk storage liquids.

On March 17, 1981, the Indiana State Board of Health (ISBH) sampled two wells at the ECC site: MW-2A and MW-1B (Figure 1). The analysis of the sample from the shallow well, MW-1B, indicated the presence of several organic compounds. The organic contaminants found in the sample were:

methylene chloride	5.7 mg/l
1,1-dichloroethane	950 mg/l
trichlorethylene	10 mg/l



LEGEND

- ● REMEDIAL INVESTIGATION MONITORING WELL INSTALLED JUNE AND SEPTEMBER 1983.
- O NORTHSIDE SANITARY LANDFILL MONITORING WELL OR PIEZOMETER.
- x—x ECC BOUNDARY FENCE

NOTE: All well locations are approximate

N

0 100 200

50 150

SCALE IN FEET

FIGURE 1
MONITORING WELL LOCATIONS
ECC SITE
TM 3-1

On November 29, 1982, the ISBH sampled five groundwater monitoring wells in the vicinity of the Northside Sanitary Landfill and ECC. Organic compounds, including 1.1-dichloroethane, Trans-1,2-dichlorethylene and methyl ethyl ketone were present in four of the five samples.

SCOPE

A hydrogeologic investigation was conducted to define the soil stratigraphy, characterize aquifers and determine groundwater flow directions and gradients in the vicinity of the ECC site and to define pathways of subsurface contaminant migration. Prior to collecting any additional data, existing information was reviewed. This included a search of historical aerial photographs, domestic and industrial well logs, relevant literature, and previous soil boring and monitoring well information from the ECC site and the Northside Sanitary Landfill. A subsurface exploration program was then performed to further define conditions at the site. The program included an electrical resistivity survey, test drilling with soil sampling, rock coring and installation of monitoring wells.

GEOLOGIC SETTING

Boone County, Indiana, is in a physiographic unit known as the Tipton Till Plain, a nearly flat to gently rolling glacial plain, which is the result of continental ice sheets that covered the county about 20,000 years ago. During the period, known as the Pleistocene Epoch, large quantities of earth materials were deposited upon the bedrock surface, with a maximum thickness approaching 350 feet. The major aquifers in Boone County are in sand and gravel deposits of glacial origin. These deposits are also important sources of aggregate materials.

The bedrock formations beneath the glacial drift in Boone County consist of limestones and dolomites of Silurian and Devonian age and shales of Devonian and Mississippian age. The beds generally dip about 10 to 30 feet per mile to the southwest toward the Illinois Basin. In general, the Silurian and Devonian age formations produce small to moderate amounts of water, while the Devonian and Mississippian age shales are not usually good water producers.

SUBSURFACE EXPLORATION PROGRAM

The subsurface exploration program was conducted between May and September 1983. It involved an electrical resistivity survey performed by Gilkeson and Heigold of Champaign, Illinois, and a test drilling and monitoring well installation program performed by Mateco Drilling Co. of Grand Rapids,

Michigan, and ATEC Inc., of Indianapolis, Indiana, and directed by CH2M HILL.

ELECTRICAL RESISTIVITY SURVEY

An electrical resistivity survey was conducted to investigate the presence and lateral continuity of shallow sand and gravel deposits and the presence of fine-grained glacial tills in the vicinity of the ECC site. A secondary objective was to investigate the presence of a groundwater contaminant plume; however, baseline resistivity values were not available and measured resistivities could not be related to the presence of contaminants. The resistivity survey was useful in defining layer characteristics of geologic materials to depths greater than 100 feet. A report on the earth resistivity investigation is presented in Appendix A.

TEST DRILLING

A series of monitoring well clusters were installed around the ECC site. The wells were classified into three groups based on their relative borehole depths. Shallow boreholes (wells) were drilled to a maximum depth of about 30 feet. Intermediate boreholes (wells) were drilled to approximately 100 feet. Deep boreholes (wells) were drilled into the top of rock, approximately 155 to 165 feet. Borehole locations are shown in Figure 1. All wells were located outside of the hazardous waste site and continuous monitoring with an HNu analyzer during drilling detected no readings above background.

Boreholes were advanced through the soil using hollow-stem-augers and/or rotary drilling techniques. The drilling fluid was clear water obtained from the City of Zionsville water supply and, in some cases, bentonite mud was used to complete deep boreholes. On deep and intermediate boreholes, 6- or 4-inch diameter steel casing was used to seal off near-surface aquifers while drilling into deeper water-bearing zones. Continuous split-spoon samples were taken through the upper 20 to 30 feet in one borehole at each well cluster location to define the near-surface stratigraphy and determine the setting depth of the 6- or 4-inch temporary steel casing. Exact depths of drilling and casing are noted on the boring logs in Appendix B. Split-spoon samples were collected at 5-foot intervals below the 20- to 30-foot depth to the top of rock. One NX-size core run was advanced into rock at each deep borehole, except at borehole ECC-3C where the core barrel did not work properly.

MONITORING WELL INSTALLATION

Twelve monitoring wells were installed at seven locations around the ECC site (Figure 1). Shallow and deep wells were

installed in the boreholes at the ECC-1, 3 and 4 cluster locations. Deep, shallow and intermediate wells were installed at the ECC-2 cluster location and single shallow wells were installed at ECC-5, 6, and 7. Well construction drawings are presented in Appendix C.

Once a borehole was completed, it was cleaned of drill cuttings and fluid by flushing with City of Zionsville water. The monitoring well was then installed and developed. The development procedure at shallow wells used an air compressor to evacuate water from the standpipe above the screen. An airline was lowered down the well to a depth just above the top of the screen to ensure that no air was forced into the aquifer. The column of water in the standpipe was ejected, allowing aquifer water to surge into the well through the screen. Each well was surged until the purge water no longer contained sand or silt.

Well ECC-4A was contaminated with oil because the oil filter on the air compressor failed to work properly while developing the well. As a result, two additional wells, ECC-6A and ECC-7A, were installed along the eastern boundary of the ECC site. These two wells were developed using compressed nitrogen, rather than an air compressor, to prevent the possibility of oil contamination.

All of the deep wells and the one intermediate well were artesian, flowing at the ground surface after being completed. These were allowed to flow freely for approximately 10 to 12 hours and no other development procedure was used. The flowing wells were fitted with a special packer assembly that was lowered into the well on 1-1/4-inch PVC pipe, as shown in Appendix B. This system controls flow and allows water to be evacuated above the frost penetration zone for winter operation. Water level measurements can be taken by adding additional 1-1/4-inch diameter PVC standpipes above ground surface.

Ground surface elevations were surveyed and water levels were recorded at all wells except ECC 6A and ECC 7A on June 29, 1983. Water levels were also recorded on either July 18, 19 or 20, 1983 and September 1, 1983; that were measured with an electric sounder. Water and ground surface elevations are listed in Table 1.

LABORATORY SOIL TESTING

Laboratory testing included index tests for soil identification and classification. These consisted of Atterberg limits, moisture contents and mechanical grain size analysis. Samples were selected for testing after visual classification of all samples from a borehole and were selected on the

Table 1
GROUNDWATER ELEVATIONS
ECC SITE

Well No.	Ground Surface Elevation Ft. - MSL	Top Casing Elevation Ft. - MSL	Feet from Ground Surface[a]	Elevation Ft. - MSL	Date Recorded
ECC-1A	887.13	890.13	-5.46	881.67	6/29/83
			-5.67	881.46	7/19/83
			-6.24	880.89	9/1/83
			-5.45	881.68	11/29/83
ECC-1C	886.76	889.46	+5.06	891.82	6/29/83
			+4.70	891.46	7/18/83
			+3.99	890.75	11/29/83
ECC-2A	887.21	890.21	-5.15	882.06	6/29/83
			-5.43	881.78	7/19/83
			-6.15	881.06	9/1/83
			-5.31	881.90	11/29/83
ECC-2B	886.65	889.65	+5.19	891.84	6/29/83
			+4.34	890.99	7/20/83
			+3.78	890.43	11/29/83
ECC-2C	886.80	889.70	+5.09	891.89	6/29/83
			+4.78	891.58	7/18/83
			+3.78	890.67	11/29/83
ECC-3A	876.47	878.87	-4.31	872.16	6/29/83
			-5.13	871.34	7/19/83
			-4.90	871.57	9/1/83
			-5.26	871.21	11/29/83
ECC-3C	877.19	879.59	+12.52	889.71	6/29/83
			+12.24	889.43	7/20/83
			+13.30	890.49	11/30/83
ECC-4A	884.34	887.24	-4.11	880.23	6/29/83
			-4.38	879.96	7/19/83
			-4.66	879.68	9/1/83
ECC-4C	884.54	887.24	+7.71	892.25	6/29/83
			+6.93	891.47	7/18/83
			+6.10	890.64	11/30/83
ECC-5A	887.25	889.85	-6.10	881.15	6/29/83
			-6.49	880.76	7/19/83
			-6.92	880.33	9/1/83
			-6.19	881.06	11/30/83
ECC-6A	--	--	-4.45	--	9/2/83
			-3.59	--	11/30/83
ECC-7A	--	--	-8.50[b]	--	9/1/83
			-2.43	--	11/30/83

[a] Positive sign indicates water level above ground surface; negative sign indicates water level below ground surface.
[b] Noted while drilling with hollow stem augers.

GLT90/73

basis of being representative of soil types encountered. Laboratory test results are presented in Appendix D.

Mechanical grain size analysis is useful for determining the characteristics of coarse grained soils from a single borehole and for correlating stratigraphic units with similar grain size distributions from several boreholes. Grain size distributions of relatively well sorted and rounded sands and gravels can also be used to estimate soil hydraulic conductivities. Atterberg limits and moisture contents are conducted to determine the plasticity characteristics of silts and clays. This information is useful for cross borehole correlation and for making rough estimates of soil hydraulic conductivity without performing much more costly field and laboratory tests.

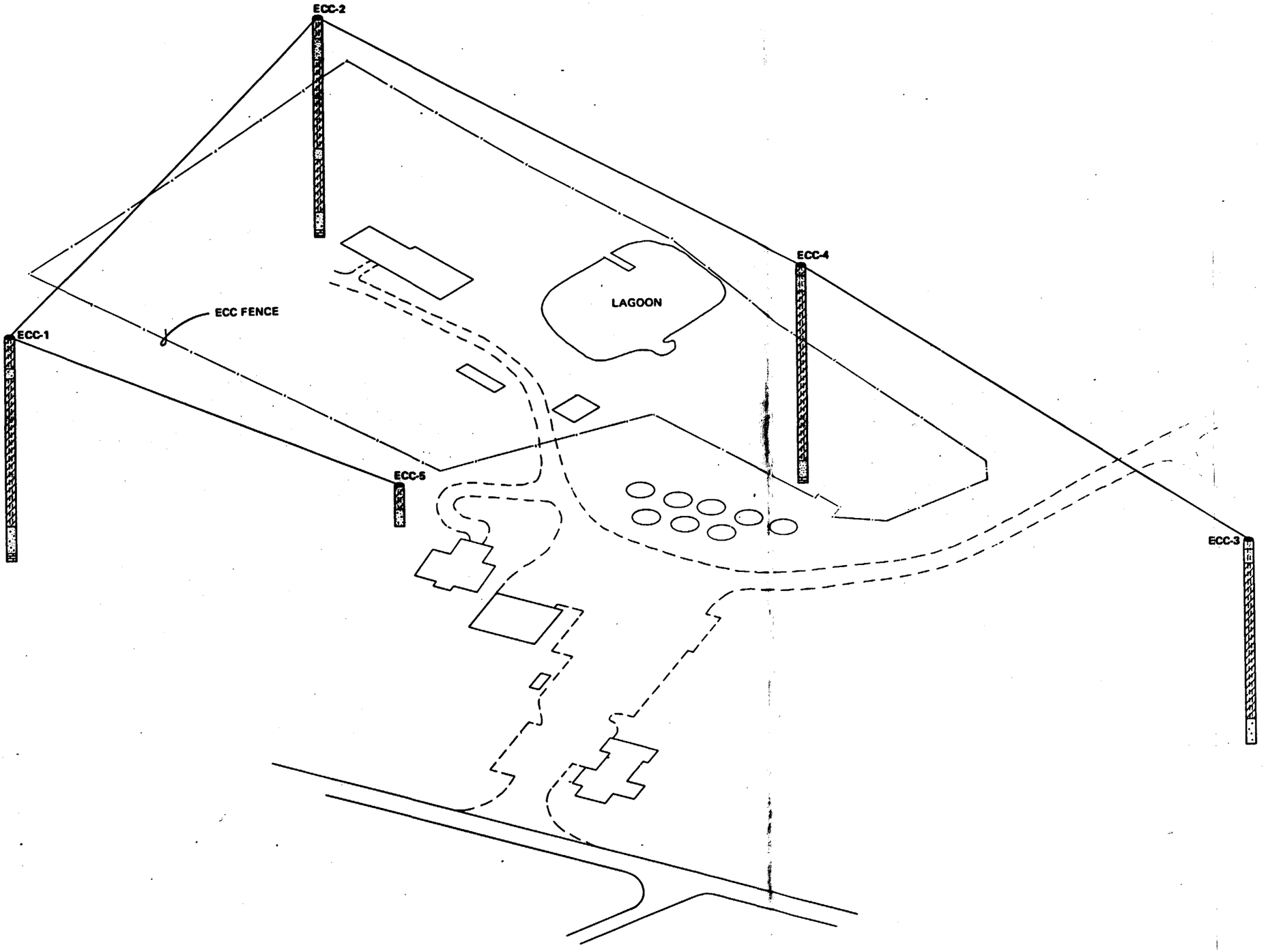
SUBSURFACE CONDITIONS

Soil types encountered from the ground surface to the top of rock are illustrated in Figure 2. These consist of glacial tills, glacial outwash and possibly some shallow alluvial deposits. The glacial till deposits, consisting predominantly of clayey silt and silty clay, formed the thickest sequence encountered. They appear to be highly overconsolidated based on Atterberg limits and relatively impermeable. Glacial outwash sands and gravels were found at all five boring locations. These consisted of fine to coarse sand and gravel that are highly permeable. Some alluvial deposits may occur near the ground surface, especially near the southeast corner of the ECC site and generally consist of fine sand and silty sand. A projection of shallow borings at the ECC site is shown in Figure 3. Included are some of the borings completed previously for the Northside Sanitary Landfill. The shallow soil stratigraphy appears to be very complex near the south end of the ECC site. This is probably due to the combination of till, outwash and alluvial deposits present in this area.

Three water-bearing zones occur at different elevations and appear to be fairly continuous under the site. These are:

- A silt sand zone, approximately 5 to 15 feet below ground surface
- A shallow sand and gravel zone, approximately 20 to 30 feet below ground surface
- A deep sand and gravel zone, approximately 150 to 165 feet below ground surface

The water table was identified while drilling with hollow-stem augers and continuous split-spoon sampling. Depths to the water table ranged from 6 feet at ECC-3 to approximately



LEGEND

ECC-1 BORING LOCATION

SILTY SAND

CLAYEY SILT AND SILTY CLAY WITH SOME CLAY (GLACIAL TILL)

SILTY SAND AND SANDY SILT WITH SOME CLAY (GLACIAL TILL)

LIMESTONE BEDROCK

SAND AND GRAVEL (GLACIAL OUTWASH)

SAND

HORIZONTAL SCALE IN FEET

0 50 100 150 200

VERTICAL SCALE IN FEET

0 40 80 120 160

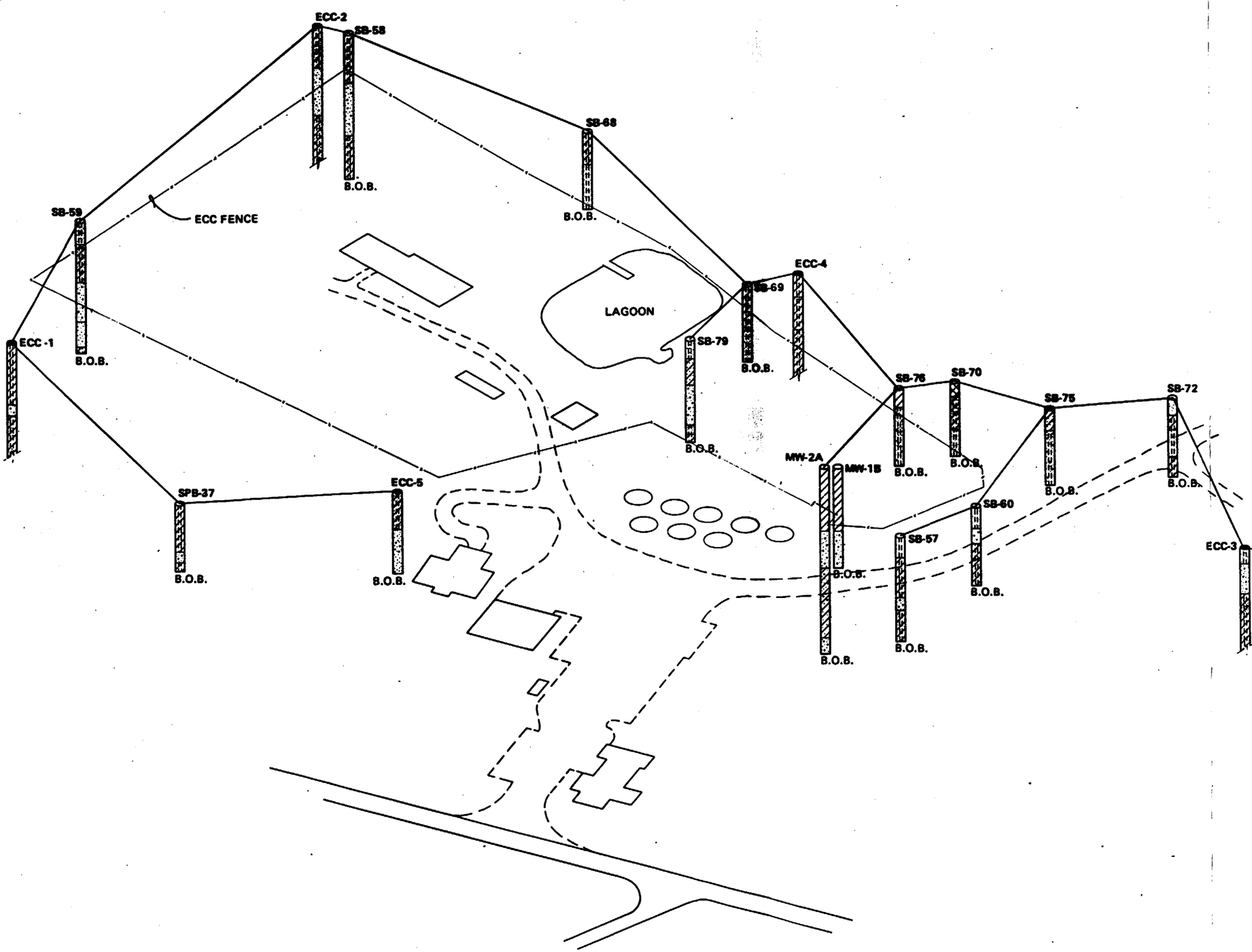
HORIZONTAL SCALE: 1" = 100'

VERTICAL SCALE: 1" = 80'

N

NOTE: Shallow boring ECC-5 included for comparison purpose.

FIGURE 2
ISOMETRIC PROJECTION OF DEEP BORINGS
ECC SITE
TM 3-1



LEGEND

ECC-1 REMEDIAL INVESTIGATION BORINGS

SB-72 PREVIOUS BORINGS

B.O.B. BOTTOM OF BORING

SAND

SAND AND GRAVEL

CLAY

CLAYEY SILT AND SLITY CLAY WITH SOME SAND AND GRAVEL (GLACIAL TILL)

SANDY CLAY

SILTY SAND AND SANDY SILT

FILL

HORIZONTAL SCALE IN FEET

0 50 100 150 200

VERTICAL SCALE IN FEET

0 20 40 60 80

VERTICAL SCALE: 1" = 40'

HORIZONTAL SCALE: 1" = 100'

N

FIGURE 3
ISOMETRIC PROJECTION OF SHALLOW BORINGS
ECC SITE
TM 3-1

10 feet at ECC-1, 4 and 5, to 15 feet at ECC-2. Approximate water table elevations are illustrated in Figure 4. The water table occurred in fine-grained soils, usually sandy silts or silty sands at ECC-1, 2, 4, 5, 6 and 7. At ECC-3, it occurred in a fine sand, relatively free of silt.

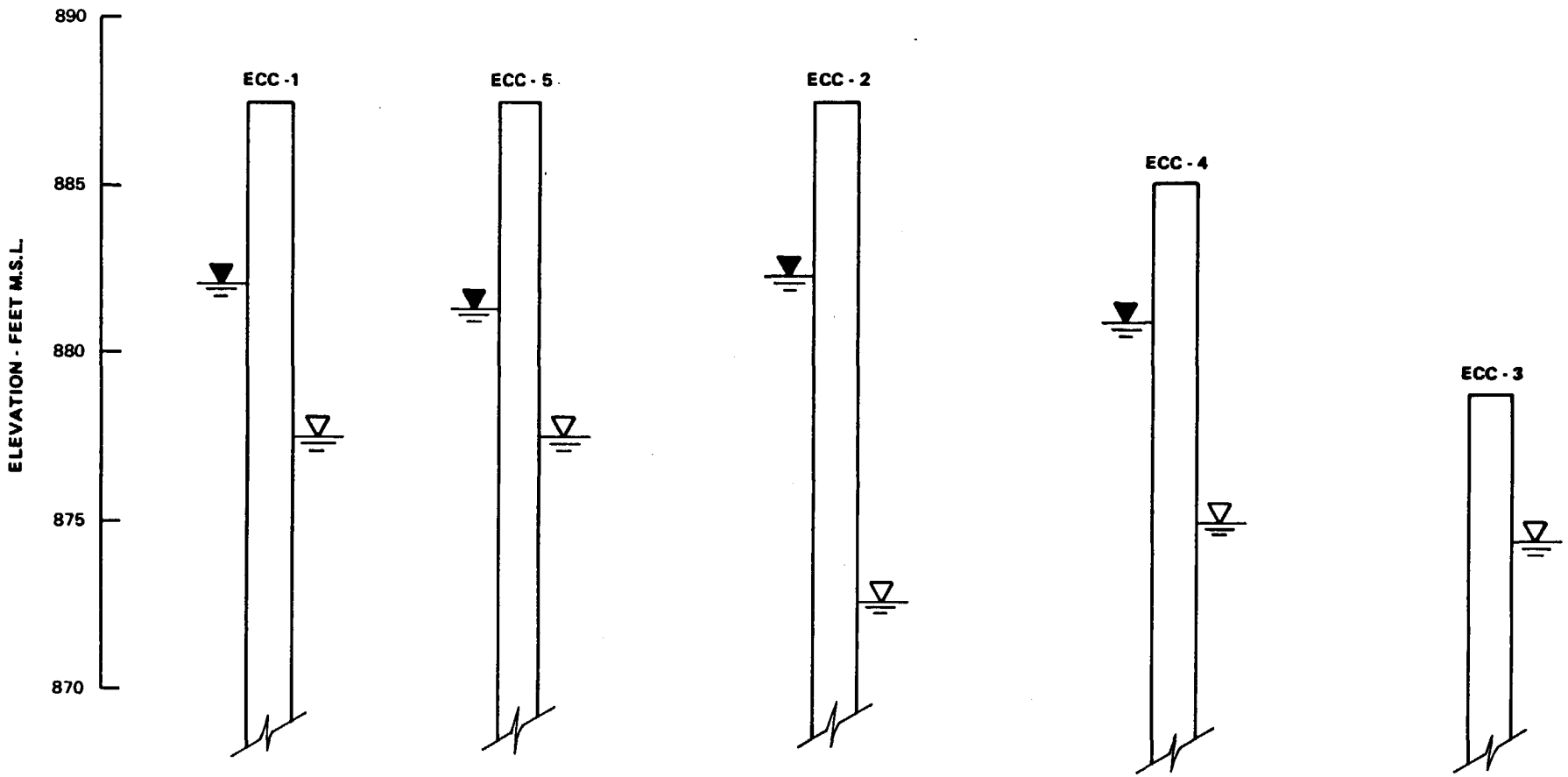
A shallow confined sand and gravel was identified between approximately the 20- and 30-foot depth at ECC-1, 2, 4 and 5. The potentiometric surface of this zone is at a higher elevation than the water table at these four boring locations, as shown in Figure 4. This zone appears to be a glacial outwash sand and gravel zone, which is confined by an overlying silty clay till. The confining upper till unit appears to be 10 to 15 feet thick throughout the northern half of the ECC site. This shallow confined sand and gravel was not found at ECC-3, which is within 250 feet of Finley Creek. The shallow confined zone at ECC-4 occurs at a higher elevation than at ECC-1, 2 and 5. The zone also consists of a finer, silty sand at ECC-4 than at the other boring locations. Due to the oil problem encountered when developing ECC-4A, two additional wells were added; ECC-6A and ECC-7A (Figure 1), along the unnamed ditch. An additional well was not added at the ECC-4 location because of the low permeability soils encountered there. The shallow confined zone was identified at the ECC-6 location and has very similar characteristics to the 20- to 30-foot depth at ECC-1, 2 and 5. At ECC-7, the zone is similar to ECC-4, with large amounts of silt and interbedded clay lenses. The maximum gradient in the shallow confined aquifer was found to be 0.005 between wells ECC-2A and ECC-4A.

The hydraulic conductivity was estimated, from grain size analysis, to be in the 10^{-3} to 10^{-2} cm/sec range.

Water levels measured in Northside Sanitary Landfill piezometers are listed in Table 2. Two Northside Sanitary Landfill piezometers, SB-57 and SB-60, are relatively close together, about 100 feet (Figure 3), but show a water level difference of over 7 feet as shown by the following measurements:

Piezometer	Ground Elevation	Water Level Elevation	
		11/15/82	9/1/83
SB-57	879.12'	880.1'	880.12'
SB-60	880.79'	872.7'	872.73'

Piezometer SB-60 appears to be monitoring the water table, while SB-57 appears to be monitoring the shallow confined aquifer. ECC-3A monitors the water table and shows water levels that correspond closely to SB-60 (Table 1). Water level contours for the water table and the shallow confined zone are shown in Figure 5.



LEGEND

▼ WATER ELEVATION IN SHALLOW CONFINED AQUIFER

▽ WATER TABLE ELEVATION NOTED WHILE DRILLING

NOTE: Shallow confined aquifer was not encountered at ECC - 3.

VERTICAL SCALE 1" = 5'

HORIZONTAL - NOT TO SCALE

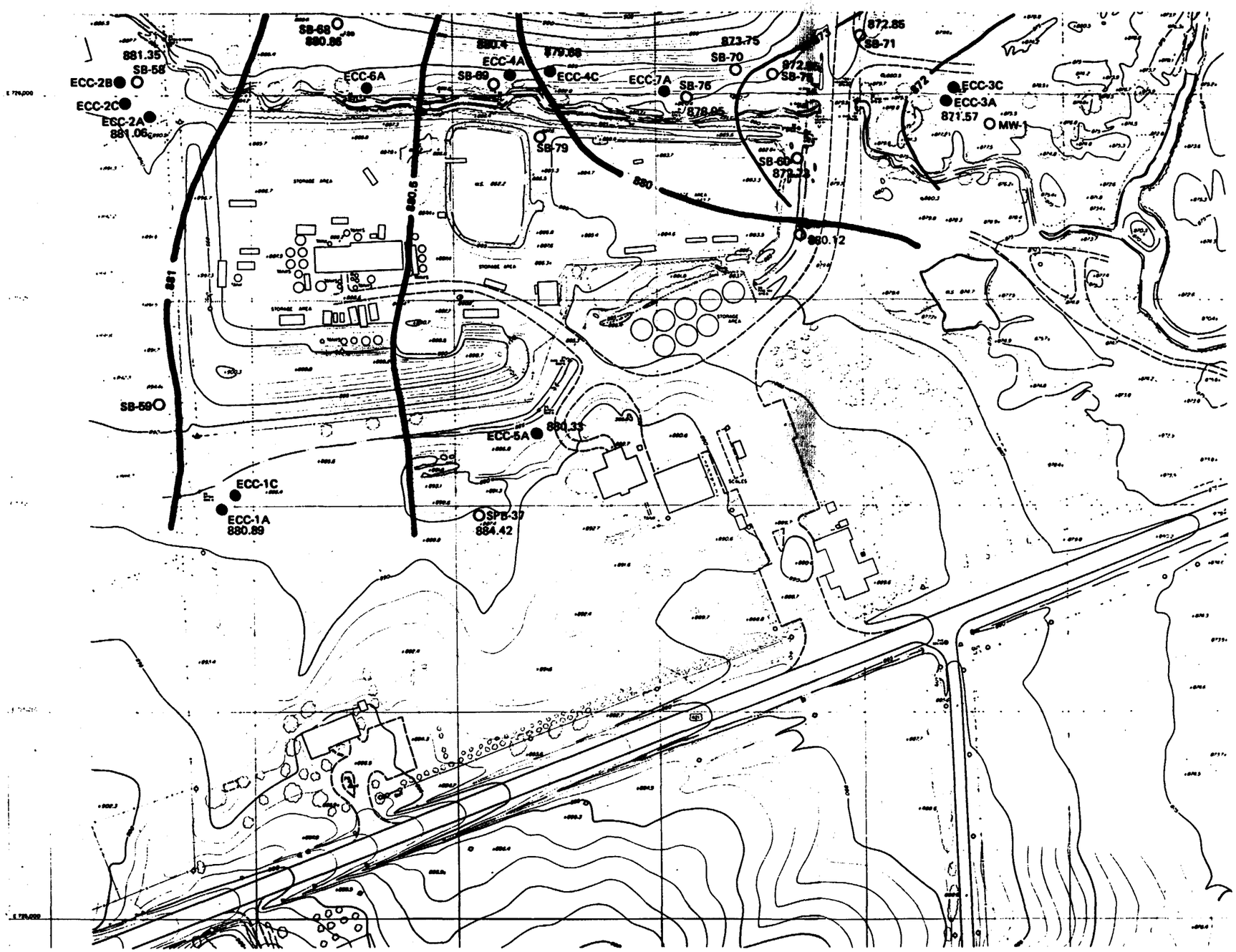
FIGURE 4
HEAD DIFFERENCE BETWEEN WATER TABLE AND SHALLOW CONFINED AQUIFER
ECC SITE
TM 3-1

Table 2
GROUNDWATER LEVELS IN NORTHSIDE SANITARY LANDFILL PIEZOMETERS

Designation	Ground Elevation	Groundwater Elevation 11/15/82[a]	9/1/83	11/29/83
MW-1	875.88	871.4	--	--
SB-53	876.15	871.2	--	--
54	877.45	872.8	--	--
55	872.44	870.7	--	--
56	874.71	870.7	--	--
57	879.12	880.1	880.12	878.05
58	886.77	881.3	881.35	882.18
59	892.85	881.0	--	--
60	880.79	872.7	872.73	872.21
61	875.71	871.6	--	--
62	887.36	889.5	--	--
63	890.55	891.3	--	--
64	887.12	890.1	--	--
65	876.00	871.8	--	--
66	881.71	--	--	--
67	878.69	--	--	--
68	888.23	881.4	880.86	881.72
69	884.70	880.9	880.40	881.17
70	883.44	874.3	873.75	873.22
71	880.19	872.6	872.85	872.14
72	888.43	873.1	--	--
73	879.53	871.8	--	--
74	877.88	871.0	--	--
75	880.29	873.2	872.95	872.02
76	880.85	879.9	878.95	879.75
77	892.34	883.9	--	--
78	885.43	--	--	--
79	888.06	--	--	--
80	873.80	--	--	--
MW-2	877.18	875.18	--	--
MW-3	884.58	878.67	--	--
MW-4A	885.10	883.68	--	--
MW-5	886.90	882.32	--	--
MW-6	916.56	901.23	--	--
MW-7	907.83	889.83	--	--
37	888.22	884.05	884.42	886.99

[a] November 15, 1982, water levels provided by ISBH.

GLT90/76



LEGEND

- ● REMEDIAL INVESTIGATION MONITORING WELL INSTALLED JUNE AND SEPTEMBER 1983.
- ○ NORTHSIDE SANITARY LANDFILL MONITORING WELL OR PIEZOMETER.
- x—x ECC BOUNDARY FENCE

CONTOURS FOR SEPTEMBER 1, 1983 DATA

- 880 SHALLOW CONFINED AQUIFER
- 872 WATER TABLE (UNCONFINED)

NOTE: Piezometer SPB-37 may not be operating properly.

N

0 100 200

50 150

SCALE IN FEET

FIGURE 5
GROUNDWATER CONTOUR MAP
ECC SITE
TM 3-1

A deep confined zone was found in outwash sands and gravels near the top of rock in all four deep borings (Figure 2). The potentiometric surface of this zone is above ground surface throughout the site, as shown in Table 1. This aquifer is confined by an extensive sequence of overlying till, which consists of very stiff to hard clayey silts and silty clays with very low relative permeabilities, based on Atterberg limits and visual classification. The natural moisture contents and Atterberg limits indicate that this till is highly overconsolidated. The maximum gradient in the deep contined aquifer was found to be 0.005 between wells ECC-3C and ECC-4C. The hydraulic conductivity was estimated, from grain size analysis, to be in the 10^{-4} to 10^{-3} cm/sec range.

Several other sandy zones in the till are possibly small outwash stages and may be water-bearing zones. Monitoring well ECC-2B is completed in such a zone, approximately 100 feet below ground surface. The water level in ECC-2B is very close to the water level in the deep well, ECC-2C (Table 1). This zone is about 10 feet thick; however, other zones encountered were usually less than 5 feet thick and generally contained considerable amounts of silt and clay.

CONCLUSIONS

Two contined zones were identified in sand and gravel zones beneath the ECC site. The deep zone occurs at a depth of about 155 to 165 feet below ground surface and just above the top of rock surface. A shallow confined zone occurs at about 20 to 30 feet below ground surface. A thick glacial till sequence of hard silty clay and clayey silt separates the two. The upper zone appears to be confined by a silty clay layer. The potentiometric surface of the deep zone was found to be above ground surface at all four deep boring locations. The potentiometric surface of the shallow aquifer was above the water table at all boring locations except ECC-3, where the shallow confined zone was not encountered. Flow in both zones appears to be generally to the south, toward Finley Creek.

The water table or top of the zone of saturation in the near surface soil was identified while drilling with hollow stem augers. It occurred in fine grained soil, usually sandy silt or silty sand, except at the ECC-3 boring location, where it occurred in a clean fine sand.

Possible groundwater contaminant sources at the ECC site include the cooling water pond, the surface storage areas and spill areas around the bulk tanks. Possible pathways of contamination appear to be in the water table aquifer and along the unnamed ditch, especially near the southeast corner of the ECC site where relatively permeable soils exist near ground surface. Contaminants may also be migrating in

the shallow confined aquifer in the vicinity of the cooling water pond, which may be excavated to a depth below the top of this aquifer. Contamination of the deep confined aquifer is unlikely because ot the thick sequence of low permeability soils that act as a confining layer and the very high potentiometric surface ot the aquifer, which causes an upward gradient throughout the confining layer.

GLT90/54

APPENDIX A

ELECTRICAL RESISTIVITY SURVEY

AN ELECTRICAL EARTH RESISTIVITY INVESTIGATION IN THE VICINITY OF THE ENVIRONMENTAL CONSERVATION AND CHEMICAL CORPORATION SITE

Robert H. Gilkeson and Paul C. Heigold

Introduction and Physical Setting

This report presents findings from the application of the surface electrical earth resistivity method to define shallow geologic materials in the vicinity of the Environmental Conservation and Chemical Corporation Site (ECC). The study area is shown on plate 1. The ECC Site is located adjacent to U.S. Route 421, approximately 10 miles north of the corporate boundary of Indianapolis in the eastern part of Boone County, Indiana. The physiographic setting of the area surrounding the site is the Tipton Till Plain, an extensive flat to gently rolling region formed on ground moraine till deposited during the Wisconsinan glacial advance.

The ECC Site is situated immediately adjacent to a large municipal refuse landfill. An unnamed stream flows southward along the east side of the site, between the site and the covered surface of the landfill. Final cover elevations on the top of the landfill are 994 feet above sea level. Excluding the elevations on the landfill, elevations over the rest of the study area vary from approximately 906 feet in the northwestern corner to less than 869 feet along Finley Creek in the southern part.

There are drainageways along the west, south and east sides of the ECC Site. The drainageways meet near the southeast corner of the site. At a distance of 400 feet south of the junction, the combined drainage discharges into Finley Creek.

The highest elevations on the ECC Site are in a bermed area along the northwestern and northern side of the site. Elevations along the top of the berm range from 896 feet to 900 feet above sea level. Elevations on the drum storage areas within the site range from approximately 883 feet to 887 feet above sea level. Surface water from a large part of the site drains into a cooling water lagoon that is present in the east-central part of the site.

Elevations in the floor of the drainageway along the east side of the site vary from 882 feet at the northeastern corner of the site to 875 feet at the junction of the two streams in the southeastern corner of the site. Elevations in the floor of the drainageway at the northwestern corner of the site are 886 feet above sea level.

The drainageways may be zones of discharge for groundwater in short flow-paths from the site. However, a component of recharge on the site may flow southward in the shallow geologic materials to zones of discharge along Finley Creek. The composition of the shallow geologic materials is an important control on the migration of contaminants away from the site. The texture and composition of the materials affect the velocity of groundwater and the attenuation of contaminants.

Drillers records from shallow borings in the study area have established the widespread presence of sand and gravel deposits in the shallow geologic materials. The borings also established that the sand and gravel was underlain by fine-grained glacial till. Four deep borings located in the vicinity of the ECC Site that were recently drilled to the bedrock surface found thick deposits of glacial till. Intertill deposits of sand and gravel were present in some of the borings. These sand and gravel deposits are laterally discontinuous. The total thickness of unlithified materials at the boring sites varied from 155 feet to 166 feet. A basal zone of sand and gravel (thicknesses varying from 10 to 20 feet) was present in all four borings. At three sites, the sand and gravel was in open connection with the limestone bedrock—at one site an 8 foot thick layer of glacial till separated the sand and gravel from the bedrock. Bedrock surface elevations at the sites of the four borings range from 720.5 to 724.5 feet above sea level. Monitoring wells constructed in the deep sand and gravel deposits established that artesian conditions were present. The thick deposits of glacial till and the upward groundwater gradients

in these materials are an important safeguard to prevent contamination of groundwater resources in the deep sand deposits and in the limestone bedrock.

A field investigation with the surface electrical earth resistivity method was conducted on the site to obtian information on the geologic materials. The geophysical investigation was designed to investigate the presence and lateral continuity of shallow deposits of sand and gravel and the presence of thick deposits of fine-grained glacial tills throughout the study area to depths greater than 100 feet.

Electrical Earth Resistivity Investigation

Background

The resistivity of a geologic material is a function of several variables such as matrix conduction, the size, quantity and inter-connectedness of pore spaces and the ionic strength of the contained fluid. It is obvious that the resistivity of geologic materials cannot be defined in terms of lithology alone; however, some generaliztions are possible:

1. Unsatuarated geologic materials have higher resistivity values than the same materials saturated.
2. Massive rocks with little pore space have high resistivities.
3. Saturated clayey sediments have low resistivities.
4. Clean sand and gravel deposits (little clay content) that are saturated with groundwater of low ionic strength will have high resistivities.
5. Geologic materials (including sand and gravel) that are saturated with groundwater of high ionic strength may have very low resistivities.

The significance of these generalizations to the geologic materials on the ECC Site are as follows:

1. Thick sand and gravel deposits should have a significantly higher resistivity than the fine-grained glacial tills.

2. The resistivity of sand and gravel deposits near the ECC Site or the landfill may be lowered if they contain contaminanted groundwater of high ionic strength.

3. In some locations the surficial silty materials may be unsaturated and therefore have resistivities that are similar to values for sand and gravel.

4. The dense, massive limestone bedrock may have very high resistivity values.

Methods of Data Collection and Analysis

The geophysical field program was conducted on four separate dates—May 1, May 8, May 18, and May 22, 1983. The 52 stations where electrical earth resistivity measurements were taken are shown on plate 1. The study area contained many features that may interfere with surface electrical measurements (metal fences, metal buildings and tanks, buried and overhead electrical lines). Because of these features, a series of measurements were taken at each measurement station through a systematic expansion of the electrode array; a measurement technique known as vertical electrical sounding (VES). In the present study measurements were taken with a modified Schlumberger electrode array where a constant 10:1 ratio is maintained for the distance separating the current and potential electrodes. Apparent resistivities were calculated for all of the measurements and graphs (VES-profiles) were constructed for each station that showed the apparent resistivity values as a function of the distance of electrode separation. The graphs were then analyzed to reject erroneous values due to measurement error or interference. Representative VES-profiles for 4 stations are shown in figures 1 and 2. Current electrode spacings out to distances of 305 feet were used at most stations. At several stations measurements were made at current electrode separations of 656 feet. Appendix I presents the apparent resistivity values measured at each current electrode separation distance for the 52 stations. A digital computer program by Zohdy (1973) was

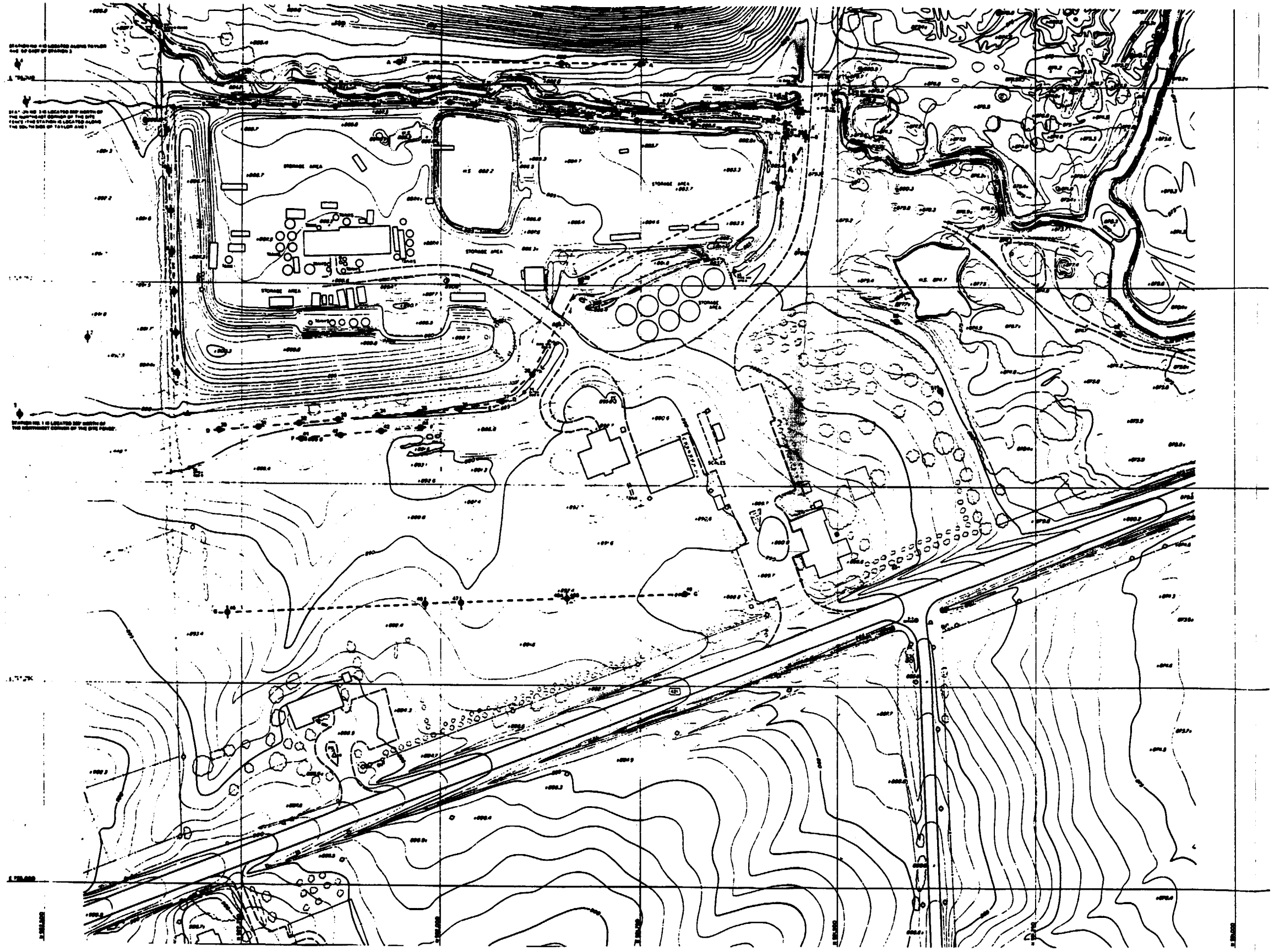


PLATE 1

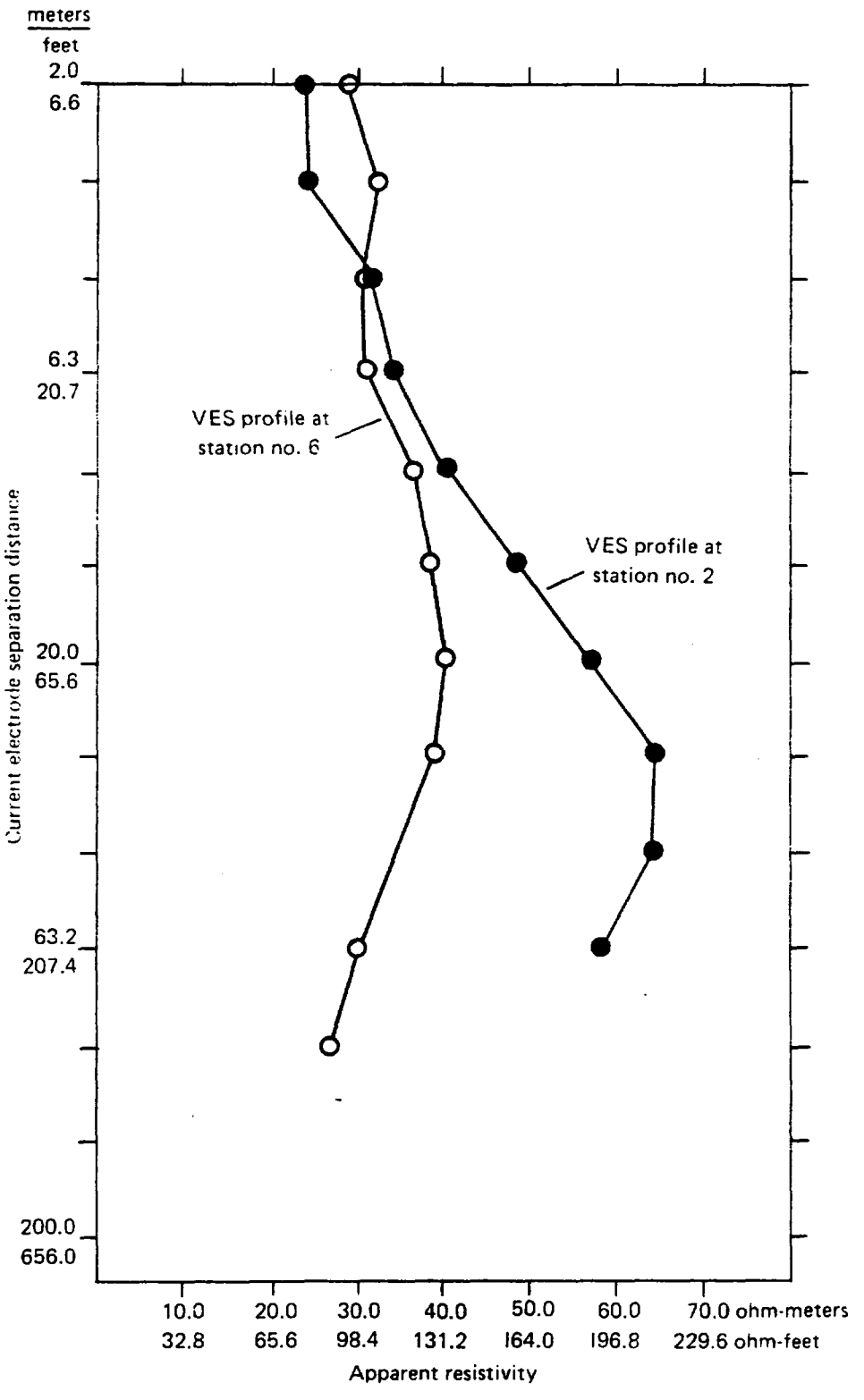


FIGURE 1. VES-profiles for station no. 6 and station no. 2 on the north side of the ECC-Site. VES-6 is located 10 feet north of the metal site fence. VES-2 is located 110 feet north of VES-6 in an open field.

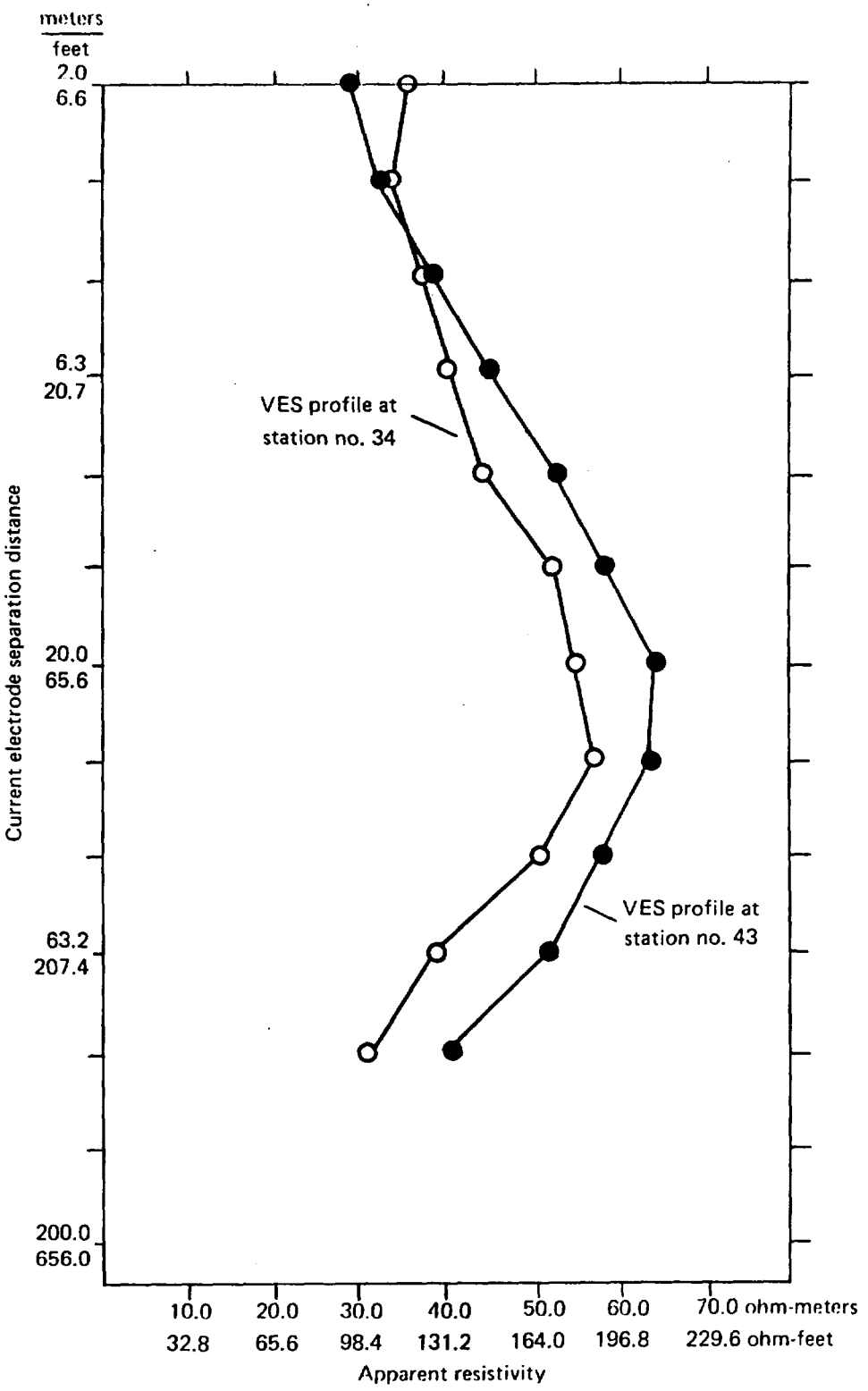


FIGURE 2. VES-profiles for station no. 34 and station no. 43 on the west side of the ECC-Site. VES-34 is located 25 feet west of the site fence. VES-43 is located 20 feet west of VES-34

used to solve the inversion problem to determine the layering parameters—"true" thickness and "true" resistivities of the geologic materials for each of the VES-profiles. The determined values are referred to as "true" in recognition that they are a best approximation of the real values. Figures 3 through 12 show the layering parameters for each VES station on strip records that include a lithologic interpretation. Most of the VES stations were located along 7 traverses shown on plate 1. Figures 5, 6, 8, 9, 10, 11 and 12 present geoelectric sections for each traverse.

The geophysical instruments used in the field program were a Bison Model no. 2350-B and an ABEM Terrameter Model no. SAS-300. The Terrameter instrument was used for all of the measurements on traverses B-B', C-C', D-D', E-E' and F-F'.

Results

The surface electrical earth resistivity measurements determined that the general sequence of geologic meaterials in the study area is a thin upper layer of low resistivity materials (interpreted to be silts and clayey silts), a middle layer of high resistivity materials (interpreted to be sand and gravel), and a thick lower layer of low resistivity materials (interpreted to be fine-grained glacial till). The middle high resistivity layer is present at all stations except for VES-12 located in the northeastern corner of the study area. The thick lower layer of low resistivity materials is present throughout the study area. Intertill deposits of sand and gravel were not detected at any of the stations. Borings have established that these deposits are present locally. These relatively thin, discontinuous deposits cannot be detected with surface electrical methods where they are interbedded in thick deposits of glacial till.

At a few stations, the electrical measurements at large electrode separation distances indicated a deep layer of high resistivity materials (the limestone bedrock).

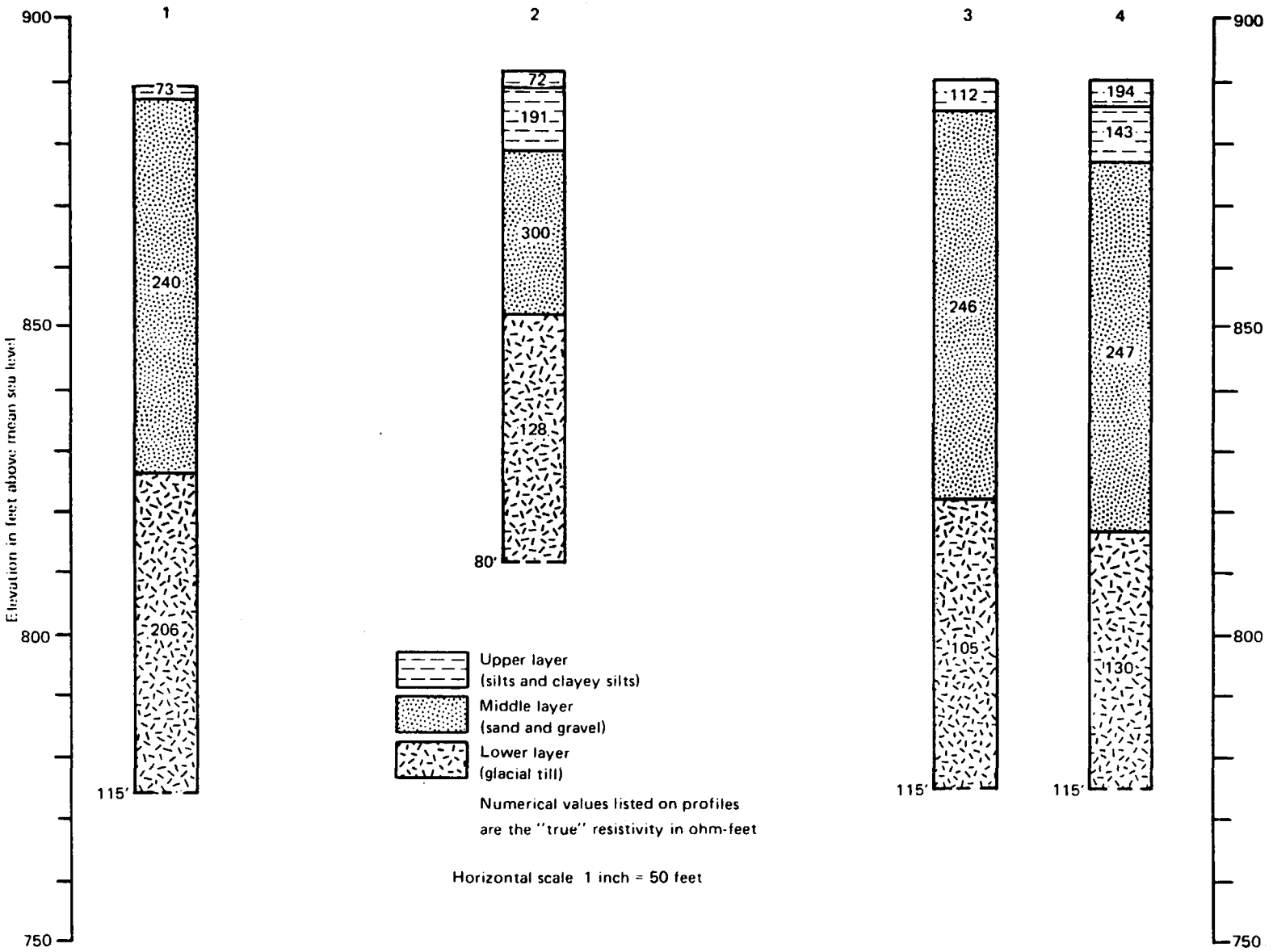


FIGURE 3. Strip records showing layering parameters for regional stations located north of the ECC-Site.

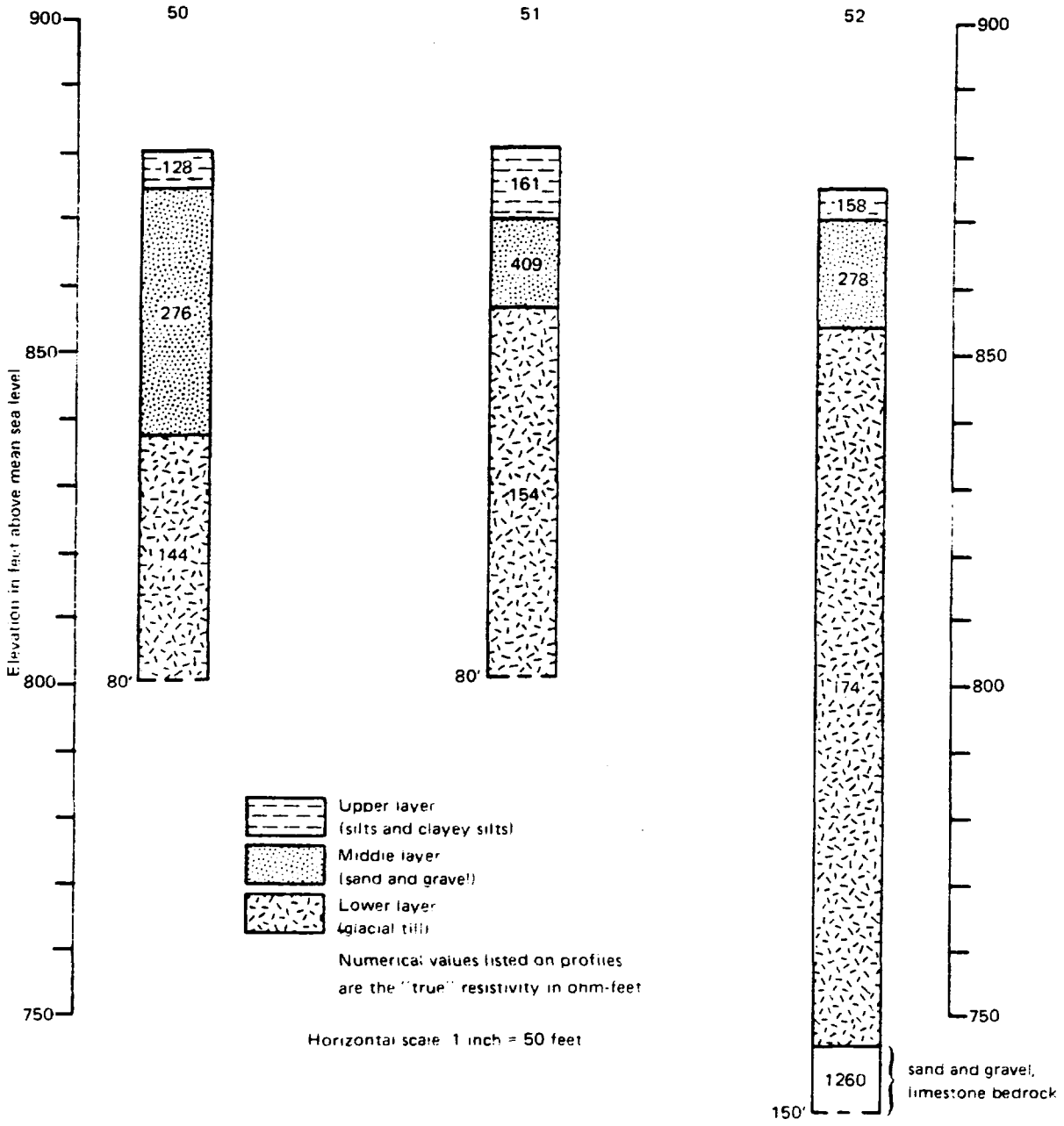


FIGURE 4. Strip records showing layering parameters for regional stations located south of the ECC-Site.

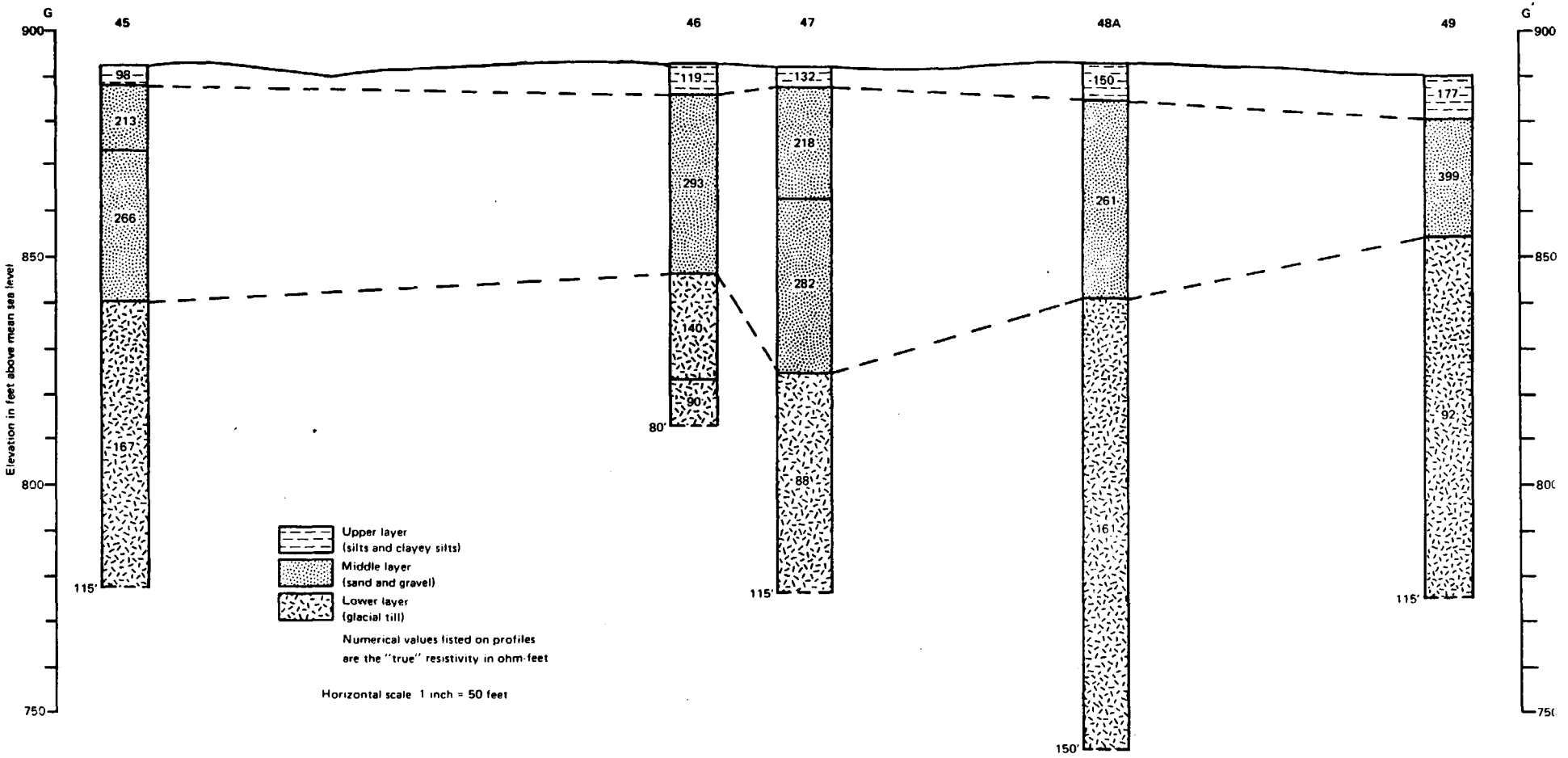


FIGURE 5. Geoelectric section for regional stations along traverse G-G' located in the western part of the study area.

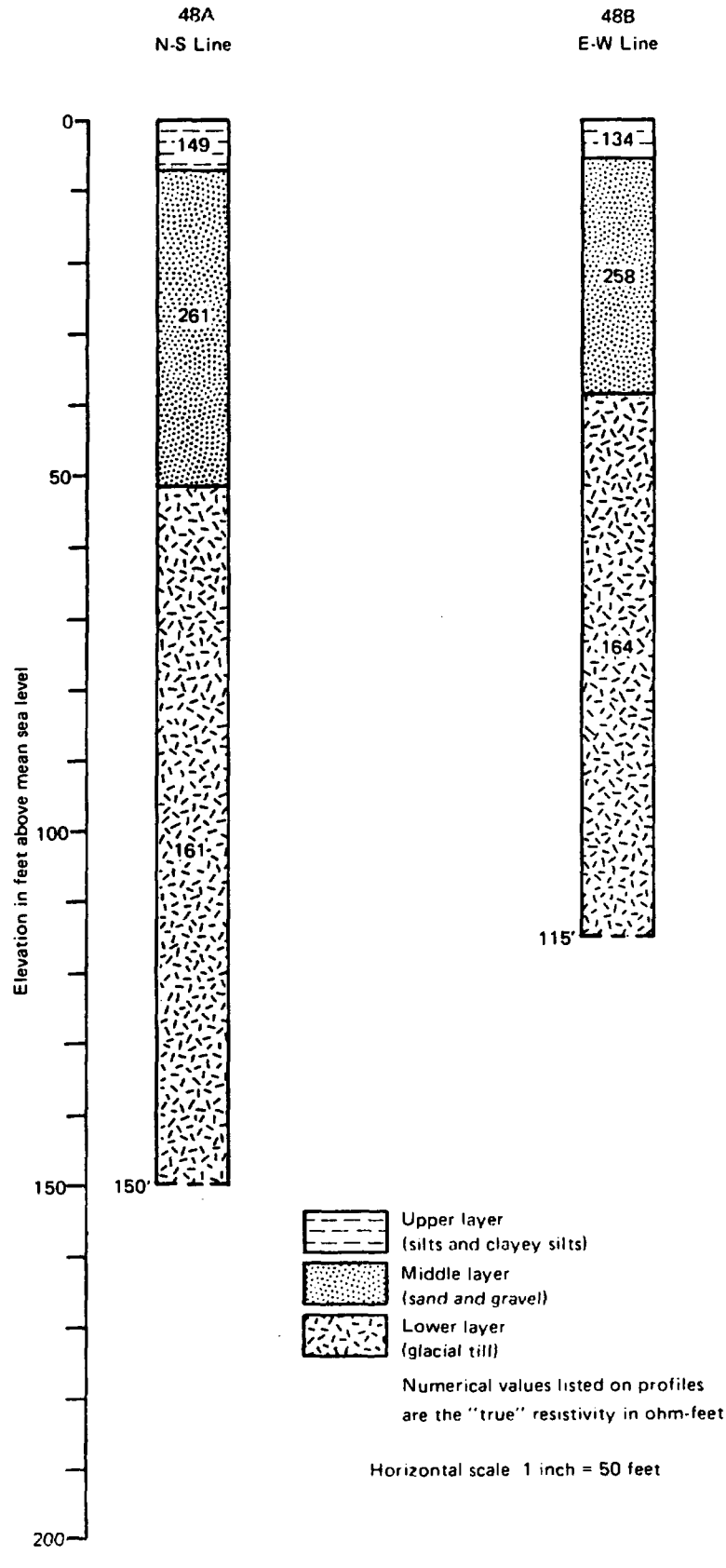


FIGURE 6. Strip records showing layering parameters for two sets of measurements taken at station no. 48. VES-48A is for a north-south alignment of electrical lines; VES-48B is an east-west alignment.

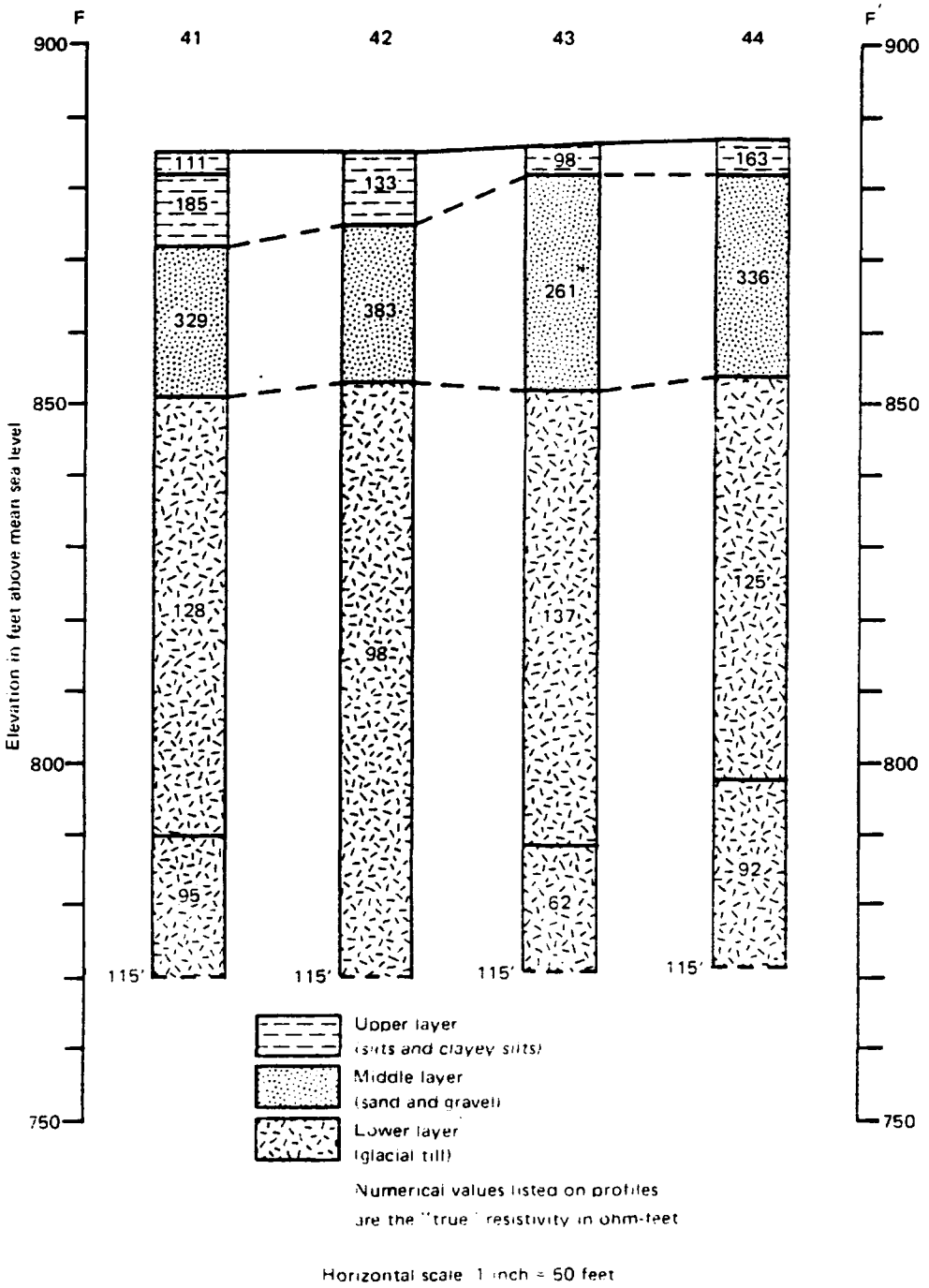


FIGURE 7. Geoelectric section for regional stations along traverse F-F' located 45 feet west of the metal fence on the west side of the ECC-Site.

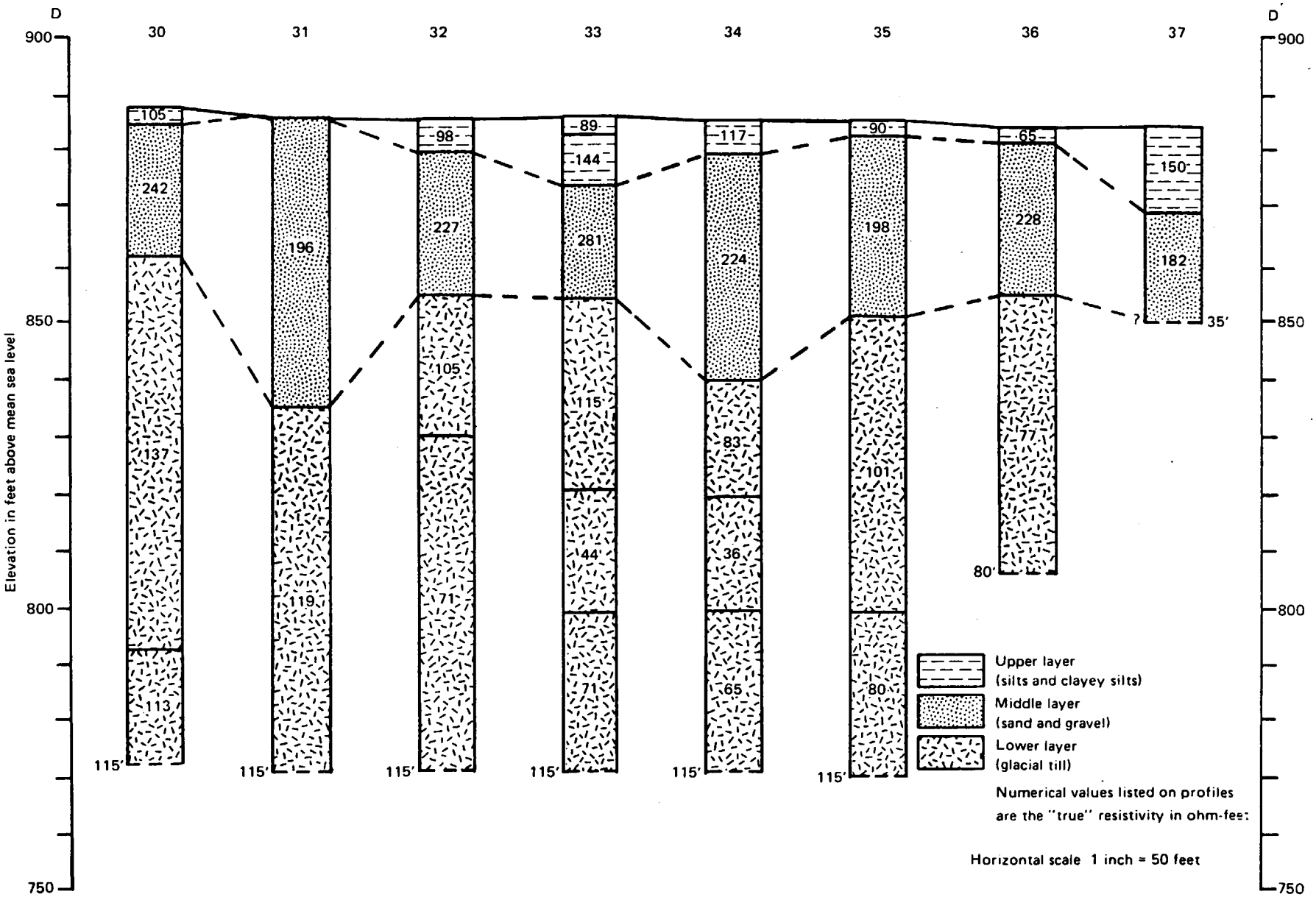


FIGURE 8. Geoelectric section for stations along traverse D-D' on the western side of the ECC-Site. Stations were located 25 feet west of the site fence.

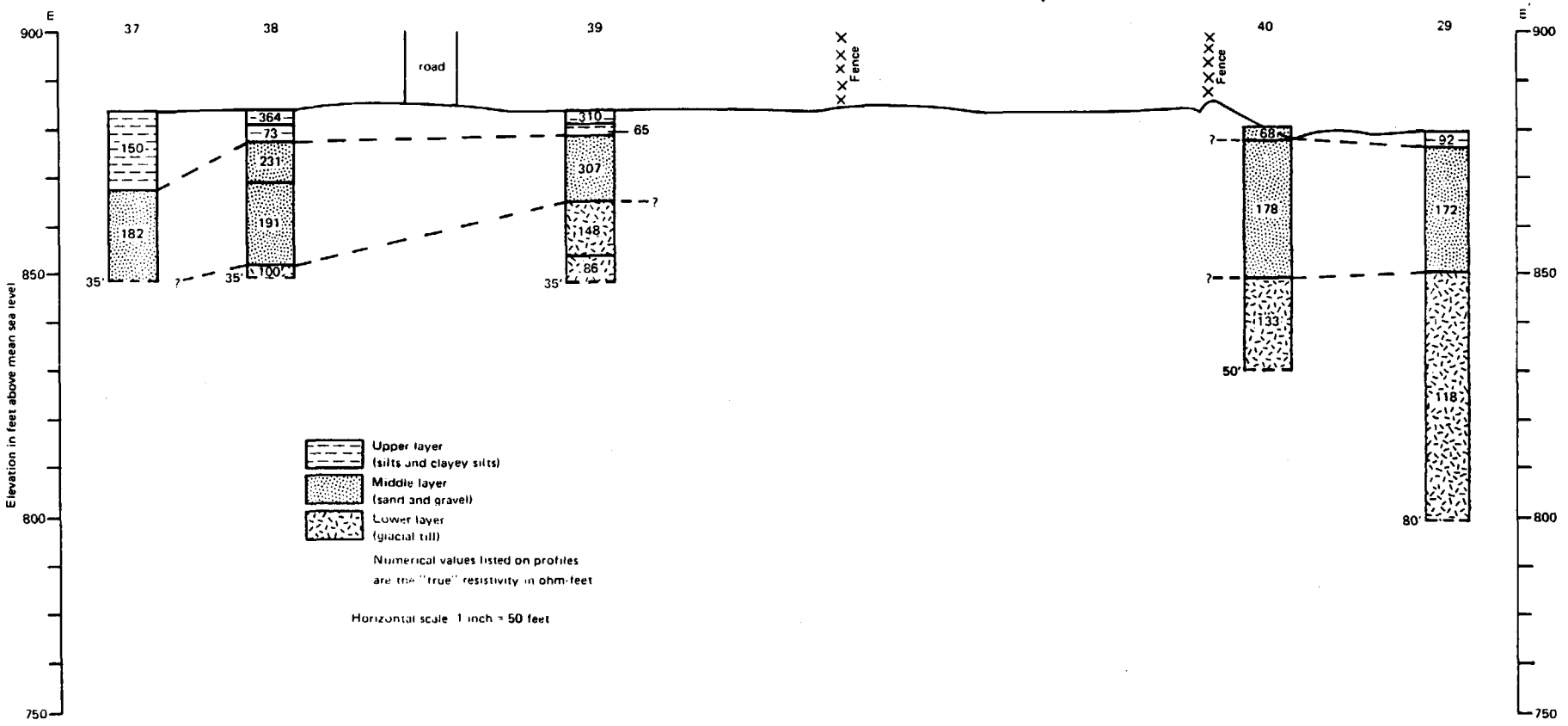


FIGURE 9. Geoelectric section for stations along traverse E-E' on the southern side of the ECC-Site.

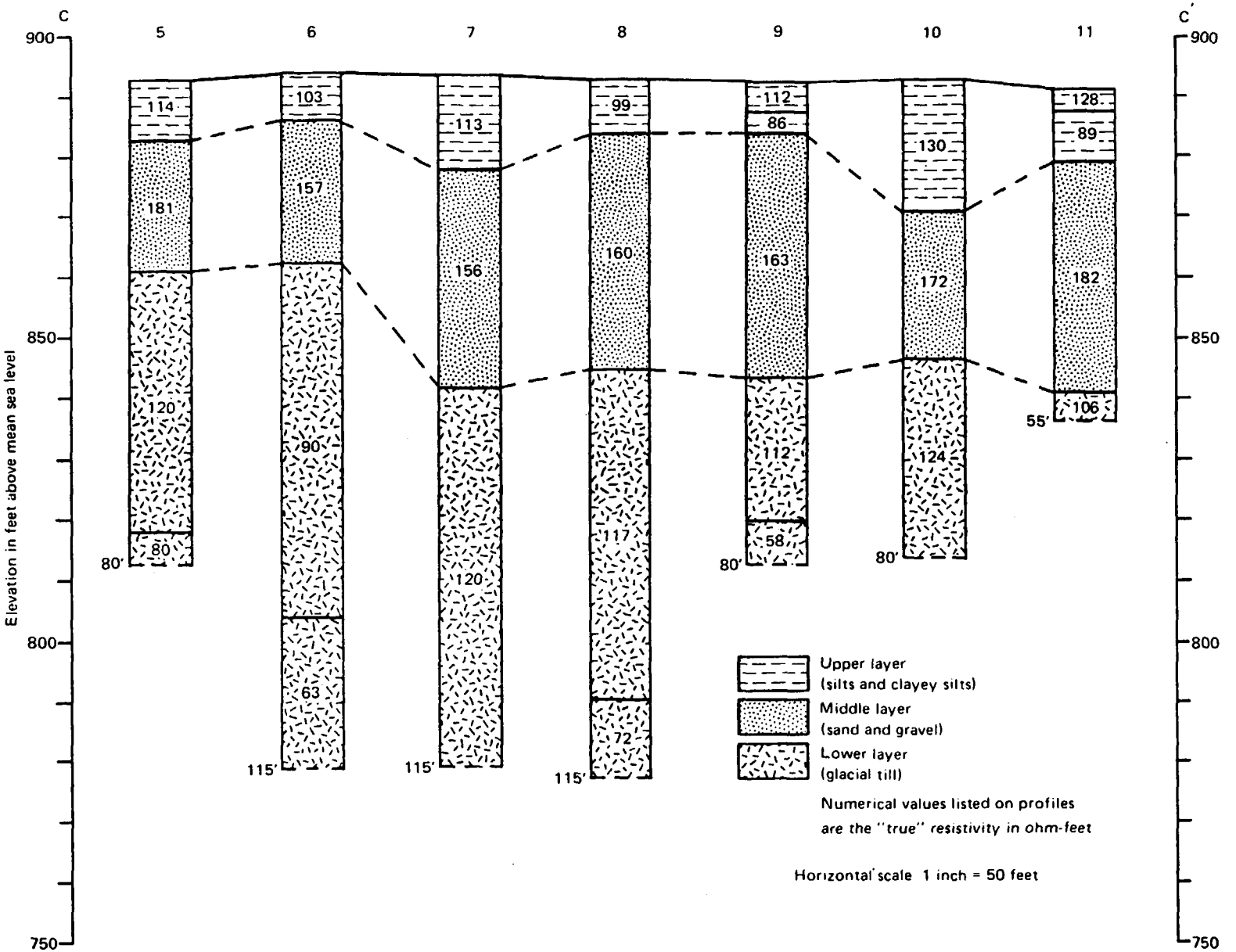


FIGURE 10. Geoelectric section for stations along traverse C-C' on the northern side of the ECC-Site. Stations were located 10 feet north of the site fence.

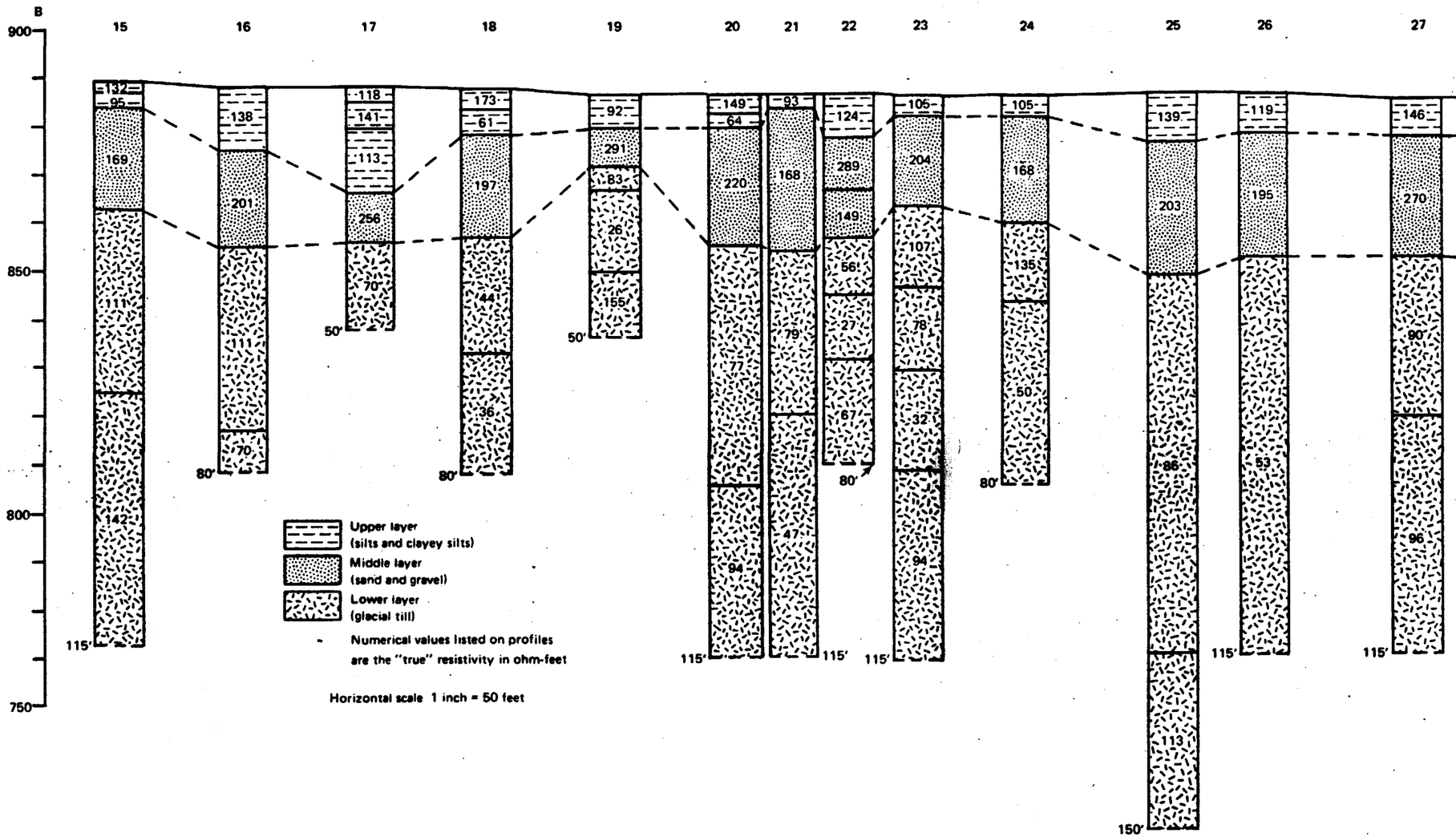


FIGURE 11. Geoelectric section for stations along traverse B-B' on the eastern side of the ECC-Site. Stations were located 5-10 feet east of the site fence.

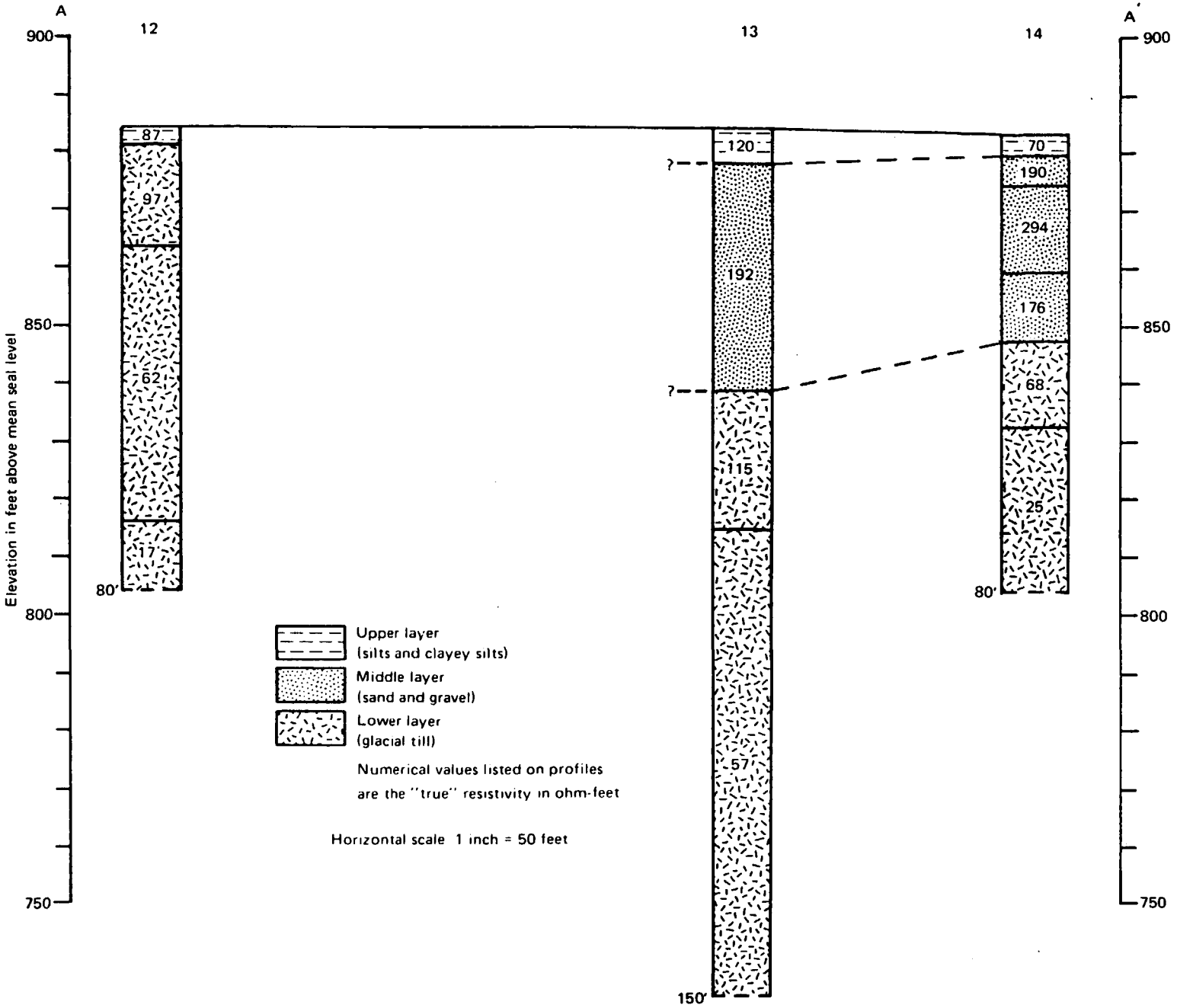


FIGURE 12. Geoelectric section for stations located east of the unnamed drainage-way on the east side of the ECC-Site near the west side of the landfill.

An example shown in figure 4 is the "true" resistivity of 1260 ohm-feet measured for geologic materials at depths greater than 140 feet at VES-52. A resistivity value of this magnitude is reasonable for the limestone bedrock. However, the available space in the study area did not allow the long current electrode separation distances necessary to accurately characterize the deeply buried limestone bedrock. Also, the very high resistivity of the limestone bedrock "masks" detection of the overlying basal sand and gravel deposits.

Table 1 compares the thickness and depth interval for the middle high resistivity layer (sand and gravel) at VES stations to the thickness of sand and gravel reported in drillers records for shallow borings at nearby locations. The approximate distance separating the VES stations and the borings is listed in the table. The layering parameters determined for the VES-profiles compare well to the drillers records, especially when the VES station and the boring are located close together.

Because of the significance of the drainageways to shallow groundwater flow systems and also because the shallow geologic materials can vary greatly over short lateral distances, it was necessary to locate VES stations between the drainageways and the metal fence that surrounds the ECC Site. The affect of the metal fence on the electrical measurements is problematic and was a reason for the decision to take all measurements with the VES method.

Table 2 presents the range in layering parameters determined for geologic materials in different parts of the study area; the values determined for the traverses in the immediate vicinity of the site and the landfill are evaluated separately from the 16 regional stations where electrical interference is less of a problem.

At the 16 regional stations, the "true" thickness of the middle layer (sand and gravel deposits) were determined to vary from 14 to 60 feet. The thickest deposits

TABLE 1

For the Vicinity of the Environmental Conservation and Chemical Corporation Site, A Comparison of the Distribution of Coarse-Grained Geologic Materials Interpreted from Vertical Electrical Soundings with Drillers Records from Shallow Borings

VES station no. or boring no.[a]	Total depth feet	Sand and gravel[b] Thickness feet	Depth interval feet	Elevation interval feet
Northwest[c]				
VES-30	115	24	2-26	884-860
ECC-1C	171	9	25-34	865-856
VES-45	115	32	19-51	873-841
Western[d]				
VES-37	35	19	16≥35	868≤849
ECC-5A	32	15	17≥32	869≤854
VES-36	80	25	4-30	880-854
North[e]				
VES-7	115	36	16-52	878-842
SB-59	50.5	26	23-49	869-843
Northeast[f]				
ECC-2C	165.6	20	16-36	871-851
VES-11	55	39	12-51	879-840
VES-15	115	21	5-26	884-863
East[g]				
SB-68	30	primarily fine-grained materials, 3 feet of silty sand in the depth interval of 18-21 feet		
VES-12	80	low resistivity values—fine-grained materials		
ECC-4C	165.9	primarily fine-grained materials, few thin sand layers in the depth interval of 8-15 feet		

TABLE 1 (Continued)

VES station no. or boring no.[a]	Total depth feet	Sand and gravel[b] Thickness feet	Depth interval feet	Elevation interval feet
East[h]				
VES-25	150	25	13-38	873-848
SB-79	38	24	12-36	873-849
Southeast[i]				
VES-14	80	32	3-35	880-848
SB-76	28.8	≥21.8	7≥28.8	876≤854
South[j]				
VES-40	50	28	2-30	878-850
SB-57	30.5	9	0-9	880-871
"	"	5	23.5-28.5	856.5-851.5
South[k]				
VES-29	80	25	3-28	876-851
SB-60	30	7	8-15	869-864
South[l]				
SB-54	30	23	0-23	873-850
VES-52	150	16	5-21	869-853
SB-55	25	23	0-23	872-849

a. The drillers records for the borings are in Appendix II. The approximate locations of the SB-borings are shown on a figure in Appendix II.

b. Sand and gravel present to a depth of not greater than 60 feet.

c. Boring ECC-1C is located approximately 50 feet west of VES-30 and 175 feet east of VES-45.

d. Boring no. ECC-5A is located along the western side of the site approximately 25 feet west of VES-37 and 60 feet south of VES-36.

e. Boring no. SB-59 is located along the north side of the site approximately 10 feet north of VES-7.

f. Boring no. ECC-2C is located 62 feet northeast of the northeastern corner of the site fence, approximately 100 feet northeast of VES-15 and 70 feet northeast of VES-11.

g. Boring SB-68 is located approximately 10 feet north of VES-12; boring ECC-4C is located approximately 90 feet south of VES-12.

h. Boring SB-79 is located within the ECC-Site on the south side of the lagoon approximately 60 feet east of VES-25.

TABLE 1 (Continued)

i. Boring SB-76 is located approximately 20 feet south of VES-14.

j. Boring SB-57 is located along the south side of the site approximately 10 feet north of the location of VES-40.

k. Boring SB-60 is located along the south side of the site approximately 10 feet north of the location of VES-29.

l. Boring SB-54 and SB-55 are located in the southern part of the study area. Boring SB-54 is located approximately 60 feet northeast of VES-52; boring SB-55 is located approximately 50 feet southwest of VES-52.

TABLE 2

The Range in Layering Parameters—"True" Thickness and "True" Resistivity for VES-Profiles at Measurement Stations in The Study Area

	Upper layer (silts, clayey silts)		Middle layer (sand and gravel)		Lower layer (glacial till)	
	thickness feet	resistivity ohm-feet	thickness feet	resistivity ohm-feet	thickness feet	resistivity* ohm-feet
16 regional stations away from the ECC Site or landfill	2-11	72-191	14-60	213-409	∿100	90-174
Stations on traverses near ECC Site						
B-B'	3-13	61-173	9-30	149-291	∿100	50-142
C-C'	7-22	86-128	22-40	156-182	> 80	90-124
D-D'	0-16	65-150	19-51	182-281	> 90	77-137
E-E'	3-16	65-364	14-28	172-307	> 50	118-148
Stations near the landfill on traverse A-A'	3-5	70-120	0-39	176-294	∿100	57-115

*The range does not include some anomalously low values and anomalously high values that were measured in thin layers or at the bottom of profiles.

are present in the northern and western part of the study area. The "true" resistivity of the middle layer at the 16 regional stations varied from 213 to 409 ohm-feet.

At station no. 48 on traverse G-G'; two separate sets of measurements were taken with north-south (VES-48A) and east-west (VES-48B) alignments of the electrode arrays. The layering parameters for the two VES-profiles are shown in figure 6. The layering parameters are very similar; the significant difference is a greater thickness of the middle layer for VES-48A.

The VES-profiles in figure 1 and 2 illustrate the lower apparent resistivity values that were measured at stations located near the metal fence surrounding the ECC Site. The shape of all 4 curves is characteristic of the 3-layer case where the middle layer has higher resistivity, but the apparent resistivity values are systematically lowered for the stations that are located near the metal fence. The range of values listed in Table 2 demonstrate that the "true" resistivity values for the middle layer are lower for stations near the ECC Site than for the regional values. The lowest values were for stations located along traverse C-C' on the north side of the site between the metal fence and a woven wire farm fence. The ground surface and fences were wet from a rain storm when measurements were taken along this traverse. The systematic lowering of the "true" resistivity values for the middle layer is also evident when the strip records in figures 7 and 8 for stations along traverse F-F' and D-D' are compared. The stations on traverse F-F' are located 20 feet west of traverse D-D' on the west side of the drainageway.

An important control on the resistivity of sand and gravel deposits is the ionic strength of the contained groundwater. Therefore, water quality data from monitoring wells in the vicinity of the ECC Site were acquired from the Indiana Department of Public Health to investigate the possibility that the lower resistivities near the ECC Site were due to the presence of contaminants that had increased

the ionic strength of the shallow groundwater. Analyses for chloride, total dissolved solids and specific conductance are tabulated for groundwater samples from 9 shallow monitoring wells in the study area on a map in Appendix III.

The values for chloride, total dissolved solids, and specific conductance for groundwater from 2 wells located north of the site (no. 58 and no. 59) and 1 well on the site (no. 57 located south of the lagoon) are very similar to values for those constiuents in monitoring well no. 37 located in the grass field west of the site. Specific conductance varies from 560 to 620 μ siemens/cm for the 3 wells in the vicinity of the site compared to a value of 605 μ siemens/cm for groundwater from well no. 37. Higher values for chloride, total dissolved solids and specific conductance were measured in 2 wells located immediately south of the ECC Site. For specific conductance the values range from 585-670 μ siemens/cm at well no. 57 and from 1060 to 1230 μ siemens/cm at well no. 60. Note that the highest concentration for the three constiuents were measured in shallow monitoring wells located in the southern part of the study area. Specific conductances of 1300 and 1500 μ siemens/cm were measured at well no. 56 and no. 55 respectively.

The increase in ionic strength in groundwater south of the site is sufficient to cause a decrease in the resistivity values measured for the sand and gravel deposits. However, the decrease that has occurred is not evident in the "true" resistivity values at either station no. 29 that is located near monitoring well no. 60 or at station no. 52 that is located in the vicinity of monitoring wells no. 55 and no. 56. The decline in resistivity that has occurred cannot be evaluated without values for baseline resistivities before the contamination occurred.

It is highly probable that electrical interference by the metal fences is the major reason for the lower resistivity values at stations near the ECC Site. Although the "true" resistivity of the middle layer is lowered at these stations,

the depth interval of the layer correlates well with sand and gravel deposits reported in drillers records for nearby borings. Examples listed in Table 1 are VES-37 and ECC-5A on the western side, VES-7 and SB-59 on the north side, VES-25 and SB-79 on the east side, VES-40 and SB-57 on the south side and VES-29 and SB-60 at the southeast corner of the site. The data indicate that sand and gravel deposits are present at a shallow depth throughout the vicinity of the ECC Site; at depth the sand and gravel deposits are underlain by thick deposits of glacial till. The "true" thickness of the sand and gravel deposits ranges from 10 to 50 feet. The thickest deposits were present at stations located on the north, east and southeast sides of the site.

The shallow sand and gravel deposits are absent in a locality that is directly east of the northeastern part of the ECC Site on the eastern side of the unnamed drainageway. The low "true" resistivity values determined at VES-12 shown on traverse A-A' in figure 12 indicate that the geologic materials to a depth of at least 80 feet are primarily fine-grained. This interpretation is supported by the drillers records for two borings (SB-68 and ECC-4C) that are located in the same locality. The data indicate that in this locality the sand and gravel deposits terminate a short distance east of the ECC Site approximately along a line that is marked by the drainageway. The southern distance to which the sand and gravel deposits are absent on the east side of the drainageway is not well-defined. The layering parameters determined for staions VES-13 and VES-14 indicate that the middle layer (sand and gravel deposits) is present in the southern part of traverse A-A'. This interpretation is supported by the drillers records at boring SB-76. VES-13 is located approximately 110 feet south of boring ECC-4C.

Conclusions

A surface electrical earth resistivity investigation in the vicinity of the ECC Site identified 3 layers in the unlithified geologic materials present to depths of greater than 100 feet—1) an upper layer of low resistivity materials interpreted to be silts and clayey silts, 2) a middle layer of high resistivity materials interpreted to be sand and gravel, and 3) a thick layer of low resistivity materials interpreted to be fine-grained glacial till. The lower layer is present throughout the entire study area. The middle layer (sand and gravel) occurs over most of the study area and is only known to be absent in a small locality in the northeastern part. Thickness of the sand and gravel is interpreted to vary from 0 to approximately 60 feet. The thickest deposits are present in the northern and western parts of the study area. The resistivity values indicate that the sand and gravel deposits are present throughout the vicinity of the ECC Site.

Because of the absence of baseline values, the resistivities measured in the study cannot be related to the presence of contaminants in the shallow groundwater. Electrical interference by the metal fence is believed to be the major reason for the lower resistivity values measured for the middle layer in the immediate vicinity of the ECC Site. A significant aspect of the field study was the finding that the layering parameters of geologic materials to depths of greater than 100 feet can be determined from vertical electrical sounding measurements taken at stations that are located within 5 to 10 feet of metal fences.

References

Zohdy, A.A.R., 1973. A Computer Program for the Automatic Interpretation of Schlumberger Sounding Curves Over Horizontally Stratified Media. National Technical Information Service, U.S. Dept. of Commerce PB-232703, 32 p.

Plate 1. The Study Area for the Surface Electrical Earth Resistivity Investigation in the Vicinity of the ECC-Site. The Map Shows the Locations of VES Stations and the Traverse Lines for Geoelectrical Sections.

APPENDIX I

Apparent Resistivities* For Vertical Electrical Sounding Profiles At Stations Located On The Environmental Conservation And Chemical Corporation Site

Current electrode separation distance (feet)	Vertical electrical sounding station no.** 1	2	3	4	5	6
	apparent resistivity (ohm-feet)					
6.6	92.20	75.47	114.76	192.14	120.13	96.43
9.6	101.84	81.93	115.06	203.09	113.61	99.61
14.2	139.89	102.46	128.57	167.18	113.22	102.79
20.7	165.08	112.40	147.99	161.17	116.86	111.48
30.4	178.56	134.11	161.60	164.75	124.90	120.17
44.6	195.75	158.71	179.61	172.10	134.74	126.41
65.6	215.92	189.94	205.45	190.69	145.79	132.02
96.4	223.95	210.83	216.90	213.23	141.66	125.98
141.4	227.33	211.59	222.44	209.85	137.49	119.91
207.4	225.20	223.56	201.22	208.21	122.18	105.51
304.6	222.28		227.14	188.00		91.08
447.0						116.34
656.0						98.38

*Apparent resistivities in ohm-feet as a function of the distance separating the current electrodes in feet (Schlumberger Electrode Array).

**The locations of the stations are shown on the base map.

APPENDIX I (Con't)

Apparent Resistivities For Vertical Electrical Sounding Profiles At Stations Located On The Environmental Conservation And Chemical Corporation Site

Current electrode separation distance (feet)	Vertical electrical sounding station no. 7	8	9	10	11	12
	apparent resistivity (ohm-feet)					
6.6	104.99	82.26	118.24	119.78	125.91	85.21
9.6	108.86	97.97	113.25	131.95	134.48	90.29
14.2	113.42	100.04	109.74	128.47	142.77	87.77
20.7	114.27	101.71	106.20	124.44	151.04	99.31
30.4	116.41	112.60	115.91	131.29	153.14	88.88
44.6	119.81	126.05	121.55	134.48	155.24	92.33
65.6	125.39	135.59	133.56	137.62	154.68	87.67
96.4	135.39	139.49	137.33	147.66	154.09	114.34
141.4	142.74	139.03	133.66	146.22	148.02	69.99
207.4	130.08	132.18		144.74		48.74
304.6	126.80	115.91				
447.0						
656.0						

*Apparent resistivities in ohm-feet as a function of the distance separating the current electrodes in feet (Schlumberger Electrode Array).

APPENDIX I (Con't)

Apparent Resistivities* For Vertical Electrical Sounding Profiles At Stations Located On The Environmental Conservation And Chemical Corporation Site

Current electrode separation distance (feet)	Vertical electrical sounding station no. 13	14	15	16	17	18
	apparent resistivity (ohm-feet)					
6.6	111.61	72.48	118.34	131.98	116.73	196.20
9.6	117.32	75.99	117.55	140.54	108.60	161.50
14.2	120.63	91.61	114.76	138.15	118.04	144.94
20.7	123.95	106.76	118.80	139.36	118.30	128.34
30.4	146.55	135.98	136.02	143.92	118.53	125.82
44.6	156.48	159.24	142.38	155.37	120.14	129.88
65.6	166.39	183.45	147.30	162.36	131.00	125.00
96.4	166.75	178.69	138.21	156.02	126.41	125.06
141.4	148.84	139.89	129.13	141.63	115.88	108.40
207.4	130.90		129.03	120.63		82.13
304.6	129.06		128.93			71.56
447.0	127.19		122.08			
656.0	105.51		115.19			

*Apparent resistivities in ohm-feet as a function of the distance separating the current electrodes in feet (Schlumberger Electrode Array).

APPENDIX I (Con't)

Apparent Resistivities* For Vertical Electrical Sounding Profiles At Stations Located On The Environmental Conservation And Chemical Corporation Site

Current electrode separation distance (feet)	Vertical electrical sounding station no. 19	20	21	22	23	24
	apparent resistivity (ohm-feet)					
6.6	128.96	153.89	96.49	109.58	92.29	106.00
9.6	119.16	144.71	109.12	117.39	107.55	110.10
14.2	116.07	130.97	122.67	125.19	121.91	120.47
20.7	119.75	132.54	136.18	136.90	136.28	128.31
30.4	129.16	134.11	144.32	148.58	150.68	138.41
44.6	142.02	145.79	152.45	164.62	160.35	151.14
65.6	113.84	157.47	153.43	161.08	163.14	149.86
96.4	85.64	150.09	137.56	145.27	142.94	142.64
141.4	74.78	134.64	117.62	105.18	120.67	113.32
207.4		118.17	93.31	84.78	89.83	89.60
304.6		101.71		86.16	79.11	
447.0				87.51	88.46	
656.0				82.82	64.94	

*Apparent resistivities in ohm-feet as a function of the distance separating the current electrodes in feet (Schlumberger Electrode Array).

APPENDIX I (Con't)

Apparent Resistivities* For Vertical Electrical Sounding Profiles At Stations Located On The Environmental Conservation And Chemical Corporation Site

Current electrode separation distance (feet)	Vertical electrical sounding station no. 25	26	27	28	29	30
	apparent resistivity (ohm-feet)					
6.6	161.54	84.82	184.00	177.28	97.41	119.22
9.6	153.53	103.15	167.28	156.98	103.64	130.18
14.2	145.50	113.88	150.55	143.92	107.71	151.60
20.7	140.64	120.11	158.55	147.07	137.30	184.04
30.4	146.35	126.34	166.52	154.45	151.07	205.68
44.6	152.06	146.55	180.26	165.90	166.46	204.60
65.6	159.90	148.35	194.01	171.28	181.84	203.75
96.4	164.39	148.25	182.23	164.39	172.23	194.17
141.4	141.63	121.68	160.88	141.63	162.62	193.02
207.4	125.46	92.03	123.78	112.89	135.26	148.87
304.6	109.25	71.20	86.65			139.40
447.0	105.05					210.14
656.0						212.38

*Apparent resistivities in ohm-feet as a function of the distance separating the current electrodes in feet (Schlumberger Electrode Array).

APPENDIX I (Con't)

Apparent Resistivities* For Vertical Electrical Sounding Profiles At Stations Located On The Environmental Conservation And Chemical Corporation Site

Current electrode separation distance (feet)	Vertical electrical sounding station no. 31	32	33	34	35	36
	apparent resistivity (ohm-feet)					
6.6	188.56	89.77	95.12	115.65	97.87	72.35
9.6	189.45	95.08	108.76	118.60	121.03	91.24
14.2	190.30	100.56	114.17	121.52	140.97	112.97
20.7	201.22	116.83	121.39	133.20	160.91	144.51
30.4	200.44	142.41	138.25	147.30	178.46	171.74
44.6	207.68	159.24	162.03	171.41	180.92	182.49
65.6	199.68	172.10	177.77	183.45	183.45	189.94
96.4	188.20	167.96	179.87	188.20	171.54	176.30
141.4	174.88	152.12	166.13	167.87	153.89	150.38
207.4	156.32	123.19	134.18	130.90	128.34	125.75
304.6	143.17	101.71	107.71	101.71	109.25	
447.0	188.01	132.71	143.76			
656.0	178.60					

*Apparent resistivities in ohm-feet as a function of the distance separating the current electrodes in feet (Schlumberger Electrode Array).

APPENDIX I (Con't)

Apparent Resistivities* For Vertical Electrical Sounding Profiles At Stations Located On The Environmental Conservation And Chemical Corporation Site

Current electrode separation distance (feet)	Vertical electrical sounding station no. 37	38	39	40	41	42
	apparent resistivity (ohm-feet)					
6.6	140.22	302.77	502.66	98.95	116.73	135.59
9.6	143.40	251.34	310.41	125.91	129.26	133.43
14.2	145.66	168.75	233.79	128.18	137.69	134.84
20.7	150.25	129.85	161.90	139.36	146.51	144.09
30.4	154.84	137.13	171.41	155.96	165.83	162.06
44.6	160.35	152.06	194.66	172.33	189.97	188.23
65.6	161.54	166.39	210.24	168.03	212.05	217.16
96.4	167.96	160.81	182.23	160.81	216.18	218.41
141.4				155.63	203.39	205.91
207.4					180.53	175.84
304.6					153.76	145.96
447.0					199.68	
656.0					186.17	

*Apparent resistivities in ohm-feet as a function of the distance separating the current electrodes in feet (Schlumberger Electrode Array).

APPENDIX I (Con't)

Apparent Resistivities* For Vertical Electrical Sounding Profiles At Stations Located On The Environmental Conservation And Chemical Corporation Site

Current electrode separation distance (feet)	Vertical electrical sounding station no. 43	44	45	46	47
	apparent resistivity (ohm-feet)				
6.6	95.84	71.01	107.22	114.93	140.18
9.6	106.20	76.12	122.08	122.67	152.45
14.2	126.60	109.81	151.79	126.47	164.72
20.7	150.38	125.55	157.07	147.50	175.54
30.4	174.59	156.16	177.38	160.94	186.20
44.6	190.30	186.82	197.42	184.13	196.86
65.6	211.56	220.74	210.24	209.19	208.60
96.4	207.19	231.89	225.86	227.89	216.80
141.4	192.73	218.21	228.38	216.84	225.59
207.4	172.79	181.64	227.40	193.02	213.03
304.6	136.02	151.47	216.77	—	192.14
447.0			254,40	287,30	205.65
656.0					219.16

*Apparent resistivities in ohm-feet as a function of the distance separating the current electrodes in feet (Schlumberger Electrode Array).

APPENDIX I (Con't)

Current electrode separation distance (feet)	Vertical electrical sounding station no. 48A	48B	49	50	51	52
	apparent resistivity (ohm-feet)					
6.6	150.15	142.88	89.28	139.66	254.88	125.91
9.6	146.51	138.19	77.90	128.05	202.50	159.34
14.2	152.12	154.23	89.70	135.95	174.88	167.34
20.7	159.14	162.23	108.83	157.63	169.41	196.34
30.4	192.14	188.73	131.46	179.54	181.22	216.48
44.6	206.83	201.29	159.80	201.42	210.14	230.58
65.6	226.48	220.81	189.94	226.35	237.04	241.63
96.4	228.71	228.71	210.83	234.12	229.89	237.14
141.4	220.35	215.10	218.61	218.87	215.10	227.33
207.4	207.91	201.49	189.94	203.58	205.85	214.38
304.6	202.70	188.37				234.45
447.0	170.36					291.72
656.0	137.99					

*Apparent resistivities in ohm-feet as a function of the distance separating the current electrodes in feet (Schlumberger Electrode Array).

APPENDIX II

Drillers Records for Borings in the Vicinity of the ECC-Site

The location map and the records for the SB-borings are from records on file at the Indiana Department of Public Health.

The drillers records for the ECC-borings were provided by the Milwaukee Office of CH2MHILL.

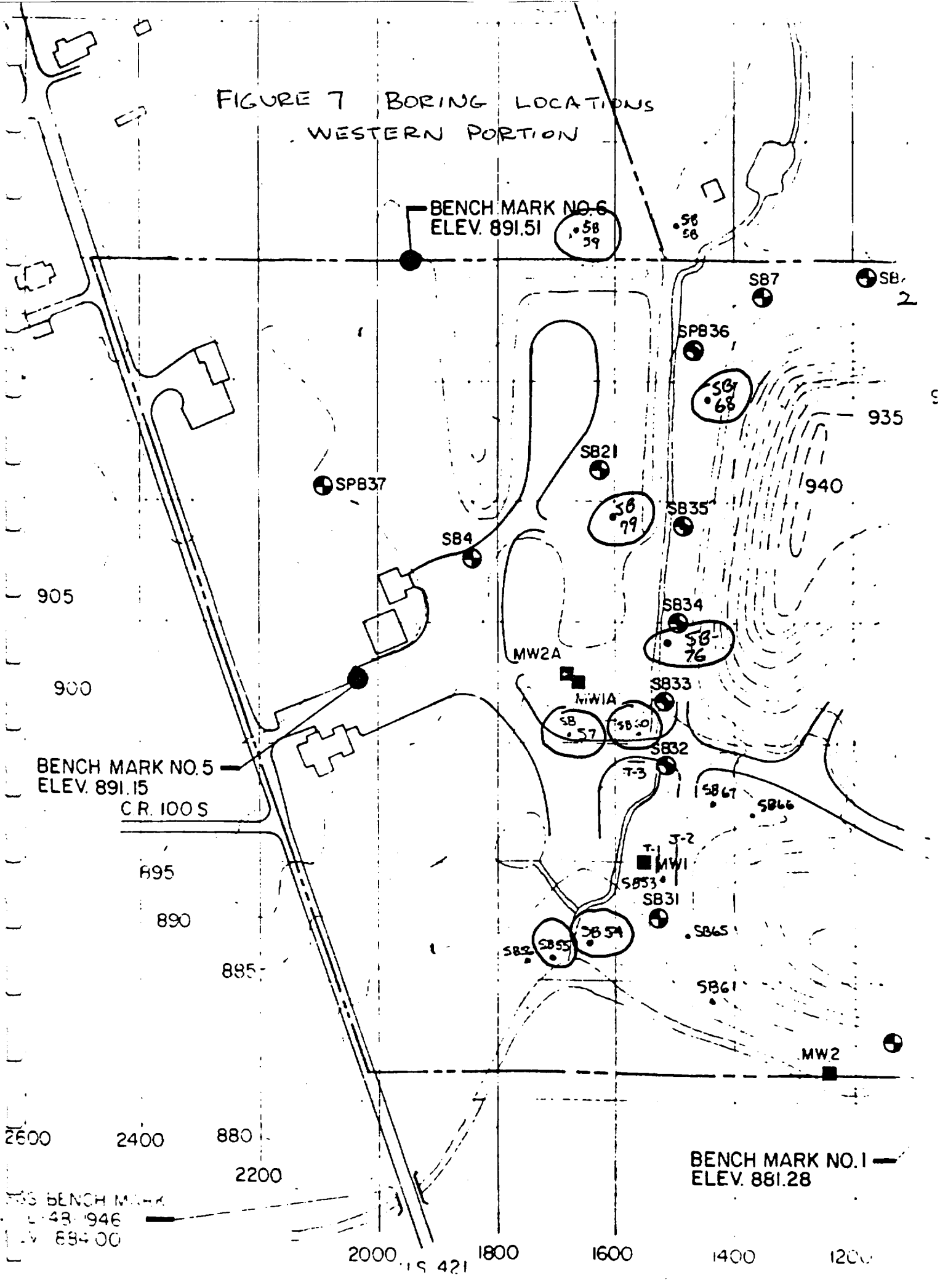


FIGURE 7 BORING LOCATIONS
WESTERN PORTION
BENCH MARK NO.6
ELEV. 891.51
SB 39
SB 56
SB7
SB 2
SP836
SB 68
935
SB21
SP837
940
SB 79
SB35
SB4
905
SB34
SB 76
MW2A
900
MW1A
SB33
SB 57
SB 101
SB32
BENCH MARK NO.5
ELEV. 891.15
C.R. 100 S
T-3
SB67
SB66
J-2
T-1
MW1
895
SB53
SB31
890
SB 54
SB65
SB55
SB52
885
SB61
MW2
2600
2400
880
2200
BENCH MARK NO.1
ELEV. 881.28
2000
1800
1600
1400
1200
US 421

ATEC Associates, Inc.

Consulting Geotechnical & Materials Engineers

LOG OF BORING NO. SB-54

CLIENT Northside Sanitary Landfill — JOB NO. 21-21043
PROJECT NAME Water Survey — START DATE 8-9-82
PROJECT LOCATION Zionsville, Indiana — FINISH DATE 8-9-82
BORING LOCATION — BORING METHOD HSA
FOREMAN J. Heffelmire — ROCK CORE DIA. ____ IN
INSPECTOR — SHELBY TUBE DIA. ____ IN

SOIL/ROCK DESCRIPTION SURFACE ELEVATION DATUM	STRATUM DEPTH, FT.	DEPTH, FT.	STD. PENETRATION SAMPLE NO.	STD. PENETRATION BLOWS/6 IN. THREE 6 IN. INCREMENTS	STD. PENETRATION RECOVERY, %	SHELBY TUBE NO.	BORING AND SAMPLING NOTES
Brown wet SAND and GRAVEL			1	1 2/3	75		
			2	6 11/11	100		
			3	15 18/25	100		
			4	18 27/34	100		Cobbles @ 23.0'
	23.5						
Gray moist HARDPAN		25	5	37 43/47	100		
			6	27 54/92	100		
		30					
Bottom test boring @ 30.0'							

WATER LEVEL OBSERVATIONS
NOTED ON RODS 6.0 FT.
AT COMPLETION ____ FT.

BORING METHOD
HSA – HOLLOW STEM AUGER
CFA – CONTINUOUS FLIGHT AUGER
DC – DRIVEN CASING
MD – MUD DRILLING
RC – ROCK CORING

*THESE SHELBY TUBE SAMPLES OBTAINED IN AN AUXILIARY BORING DRILLED A FEW FEET FROM THIS BORING

ATEC Associates, Inc.

Consulting Geotechnical & Materials Engineers

LOG OF BORING NO. SB-55

CLIENT Northside Sanitary Landfill — JOB NO. 21-21043
PROJECT NAME Water Survey — START DATE 8-10-82
PROJECT LOCATION Zionsville, Indiana — FINISH DATE 8-10-82
BORING LOCATION — BORING METHOD HSA
FOREMAN J. Heffelmire — ROCK CORE DIA. ____ IN
INSPECTOR — SHELBY TUBE DIA. ____ IN

SOIL/ROCK DESCRIPTION SURFACE ELEVATION DATUM	STRATUM DEPTH, FT.	DEPTH, FT.	STD. PENETRATION SAMPLE NO.	STD. PENETRATION BLOWS/6 IN. THREE 6 IN. INCREMENTS	STD. PENETRATION RECOVERY, %	SHELBY TUBE NO.	BORING AND SAMPLING NOTES
Black, wet SAND Organics			1	3 6/8	75		
	9.7		2	7 1/6	100		
Gray wet SAND							
	13.5						
Gray wet SAND and GRAVEL			3	34 16/15	75		Cobble at 20.0' hard drilling after cobbl
			4	16 15/45	25		
	23.5						
Brown and gray moist weathered HARDPAN		25	5				3" spoon
Bottom test boring @ 25.0'							

WATER LEVEL OBSERVATIONS
NOTED ON RODS 7.5 FT.
AT COMPLETION ____ FT.

BORING METHOD
HSA – HOLLOW STEM AUGER
CFA – CONTINUOUS FLIGHT AUGER
DC – DRIVEN CASING
MD – MUD DRILLING
RC – ROCK CORING

*THESE SHELBY TUBE SAMPLES OBTAINED IN AN AUXILIARY BORING DRILLED A FEW FEET FROM THIS BORING

ATEC Associates, Inc.
Consulting Geotechnical & Materials Engineers

LOG OF BORING NO. SB-57

JAN 31 4 49 PM '83
DIV. OF LAND POLLUTION CONTROL
STATE BOARD OF HEALTH

CLIENT Northside Sanitary Landfill — JOB NO. 21-21043
PROJECT NAME Water Survey — START DATE 8-10-82
PROJECT LOCATION Zionsville, Indiana — FINISH DATE 8-10-82
BORING LOCATION — BORING METHOD HSA
FOREMAN J. Heffelmire — ROCK CORE DIA. ____ IN.
INSPECTOR — SHELBY TUBE DIA. ____ IN.

SOIL/ROCK DESCRIPTION SURFACE ELEVATION DATUM	STRATUM DEPTH, FT.	DEPTH, FT.	STD. PENETRATION: SAMPLE NO.	STD. PENETRATION: BLOWS/6 IN. THREE 6 IN. INCREMENTS	STD. PENETRATION: RECOVERY, %	SHELBY TUBE NO.	BORING AND SAMPLING NOTES
Brown and gray SILTY SAND		5	1	3 3/5	75		
	8.5						
Gray moist SILTY CLAY with Gravel		10	2	7 8/9	100		
		15	3	4 5/8	100		
	18.5 19.0						
Wet gray SAND and GRAVEL Wet gray SILTY CLAY		20	4	5 4/3	80		
	23.5						
Gray wet SAND and GRAVEL		25	5	10 9/16	100		Hard drilling @ 24.5'
	28.5						
Gray HARDPAN		30	6 7	28 45/65	75		300# hammer 3" spoon
		35					
		40					

WATER LEVEL OBSERVATIONS
NOTED ON RODS 14.0 FT.
AT COMPLETION ____ FT.
AFTER ____ HRS. ____ FT.

BORING METHOD
HSA - HOLLOW STEM AUGER
CFA - CONTINUOUS FLIGHT AUGER
DC - DRIVEN CASING
MD - MUD DRILLING
RC - ROCK CORING
CA - CASING ADVANCER

*THESE SHELBY TUBE SAMPLES OBTAINED IN AN AUXILIARY BORING DRILLED A FEW FEET FROM THIS BORING

ATEC Associates, Inc.

Consulting Geotechnical & Materials Engineers

LOG OF BORING NO. SB-59

CLIENT Northside Sanitary Landfill — JOB NO. 21-21043
PROJECT NAME Water Survey — START DATE 8-12-82
PROJECT LOCATION Zionsville, Indiana — FINISH DATE 8-12-82
BORING LOCATION — BORING METHOD HSA
FOREMAN J. Heffelmire — ROCK CORE DIA. ____ IN
INSPECTOR — SHELBY TUBE DIA. ____ IN

SOIL/ROCK DESCRIPTION SURFACE ELEVATION DATUM	STRATUM DEPTH, FT.	DEPTH, FT.	STD. PENETRATION SAMPLE NO.	BLOWS/6 IN. THREE 6 IN. INCREMENTS	RECOVERY, %	SHELBY TUBE NO.	BORING AND SAMPLING NOTES
Brown moist SILTY SAND with trace of Clay	8.5	5	1	2 6/8	50		
Brown moist SILTY SANDY CLAY with Gravel	23.5	10	2	9 16/19	100		
		15	3	6 9/13	100		
		20			90	1	
Gray [illegible] SAND and GRAVEL			4	2 4/6	20		
			5	15 21/26	100		
			6	15 19/26	100		Dense / [illegible] and water
Gray [illegible] SAND	38.5		7	16 22/29	100		

WATER LEVEL OBSERVATIONS
NOTED ON RODS 17.5 FT.
AT COMPLETION ____ FT.

BORING METHOD
HSA – HOLLOW STEM AUGER
CFA – CONTINUOUS FLIGHT AUGER
DC – DRIVEN CASING
MD – MUD DRILLING

*THESE SHELBY TUBE SAMPLES OBTAINED IN AN AUXILIARY BORING DRILLED A FEW FEET FROM THIS BORING

ATEC Associates, Inc.

Consulting Geotechnical & Materials Engineers

LOG OF BORING NO. SB-59

CLIENT Northside Sanitary Landfill — JOB NO. 21-21043
PROJECT NAME Water Survey — START DATE 8-12-82
PROJECT LOCATION Zionsville, Indiana — FINISH DATE 8-12-82
BORING LOCATION — BORING METHOD HSA
FOREMAN J. Heffelmire — ROCK CORE DIA. ____ IN.
INSPECTOR — SHELBY TUBE DIA. ____ IN.

SOIL/ROCK DESCRIPTION SURFACE ELEVATION DATUM	STRATUM DEPTH, FT.	DEPTH, FT.	STD. PENETRATION SAMPLE NO.	STD. PENETRATION BLOWS/6 IN. THREE 6 IN. INCREMENTS	STD. PENETRATION RECOVERY, %	SHELBY TUBE NO.	BORING AND SAMPLING NOTES
Gray wet fine SAND			8	20 15/30	30		Very hard drilling @ 45.5'
	48.5						
Gray moist HARDPAN		50	9	40/50 0.4	100		3" spoon below 49.5' to 50.5'
Bottom test boring @ 50.5'							

WATER LEVEL OBSERVATIONS
NOTED ON RODS 17.5 FT.
AT COMPLETION ____ FT.

BORING METHOD
HSA – HOLLOW STEM AUGER
CFA – CONTINUOUS FLIGHT AUGER
DC – DRIVEN CASING
MD – MUD DRILLING
RC – ROCK CORING

*THESE SHELBY TUBE SAMPLES OBTAINED IN AN AUXILIARY BORING DRILLED A FEW FEET FROM THIS BORING

ATEC Associates, Inc.
Consulting Geotechnical & Materials Engineers

LOG OF BORING NO. SB-60

CLIENT Northside Sanitary Landfill — JOB NO. 21-21043
PROJECT NAME Water Survey — START DATE 8-12-82
PROJECT LOCATION Zionsville, Indiana — FINISH DATE 8-13-82
BORING LOCATION — BORING METHOD HSA
FOREMAN J. Heffelmire — ROCK CORE DIA. ____ IN.
INSPECTOR — SHELBY TUBE DIA. ____ IN.

SOIL/ROCK DESCRIPTION SURFACE ELEVATION DATUM	STRATUM DEPTH, FT.	DEPTH, FT.	STD. PENETRATION SAMPLE NO.	STD. PENETRATION BLOWS/6 IN. THREE 6 IN. INCREMENTS	STD. PENETRATION RECOVERY, %	SHELBY TUBE NO.	BORING AND SAMPLING NOTES
Dark gray moist SANDY SILT with trace of Clay		5			90	1	
	8.5						
Gray wet SILTY SAND and GRAVEL		10	1	11 11/11	20		
	13.5						
Brown wet CLAYEY SAND and GRAVEL	14.0		2	13 38/48	100		
Gray wet fine SAND	14.5	15					Twist off @17.0' back 3.0' redrill
Gray moist HARDPAN							
		20	3	20 33/57	100		
		25	4	50 0.5			
			5	50 0.3			
Bottom test boring @ 30.0'		30					

WATER LEVEL OBSERVATIONS
NOTED ON RODS none FT.
AT COMPLETION 5.0 FT.

BORING METHOD
HSA – HOLLOW STEM AUGER
CFA – CONTINUOUS FLIGHT AUGER
DC – DRIVEN CASING
MD – MUD DRILLING
RC – ROCK CORING

*THESE SHELBY TUBE SAMPLES OBTAINED IN AN AUXILIARY BORING DRILLED A FEW FEET FROM THIS BORING

ATEC Associates, Inc.
Consulting Geotechnical & Materials Engineers

LOG OF BORING NO. 68

CLIENT Northside Sanitary Landfill
PROJECT NAME Landfill
PROJECT LOCATION Zionsville, Indiana
BORING LOCATION
FOREMAN E. Lomax
INSPECTOR

JOB NO. 21-21058
START DATE 10-22-82
FINISH DATE 10-22-82
BORING METHOD HSA
ROCK CORE DIA. ____ IN
SHELBY TUBE DIA. ____ IN

SOIL/ROCK DESCRIPTION SURFACE ELEVATION DATUM	STRATUM DEPTH, FT.	DEPTH, FT.	STD. PENETRATION SAMPLE NO.	BLOWS/6 IN. THREE 6 IN. INCREMENTS	RECOVERY, %	SHELBY TUBE NO.	BORING AND SAMPLING NOTES
Brown CLAYEY SILT with Gravel		5	1	7 8/11	100		
	7.5						
Gray SILTY CLAY with Gravel		10	2	4 9/12	75		
	12.5						
Gray SANDY SILT with Gravel		15	3	9 12/15	25		
	18.0						
Gray wet SILTY SAND with Gravel		20	4	12 15/17	75		
	21.0						
Gray SANDY SILT with Gravel		25	5	18 20/27	50		Set observation well @28.5'
			6	26 31/36	100		
Bottom test boring @ 30.0'		30					

WATER LEVEL OBSERVATIONS
NOTED ON RODS 13 FT.
AT COMPLETION 17 FT.
AFTER ___ HRS ___ FT.

BORING METHOD
HSA – HOLLOW STEM AUGER
CFA – CONTINUOUS FLIGHT AUGER
DC – DRIVEN CASING
MD – MUD DRILLING
RC – ROCK CORING
CA – CASING ADVANCER

*THESE SHELBY TUBE SAMPLES OBTAINED IN AN AUXILIARY BORING DRILLED A FEW FEET FROM THIS BORING

ATEC Associates, Inc.

Consulting Geotechnical & Materials Engineers

LOG OF BORING NO. 76

CLIENT Northside Sanitary Landfill
PROJECT NAME Landfill
PROJECT LOCATION Zionsville, Indiana
BORING LOCATION
FOREMAN E. Lomax
INSPECTOR

JOB NO. 21-21058
START DATE 10-26-82
FINISH DATE 10-26-82
BORING METHOD HSA
ROCK CORE DIA.
SHELBY TUBE DIA.

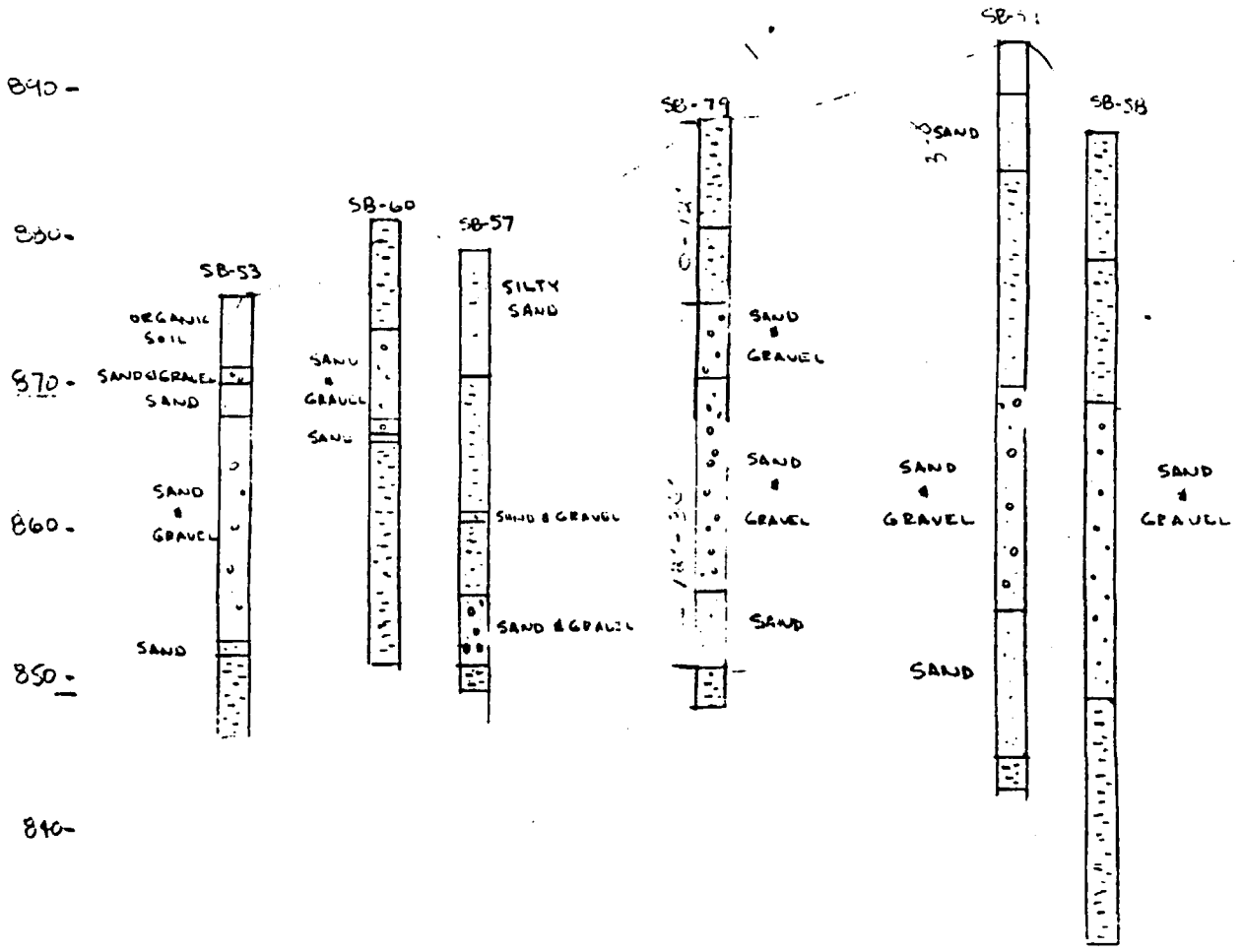
SOIL/ROCK DESCRIPTION SURFACE ELEVATION DATUM	STRATUM DEPTH, FT.	DEPTH, FT.	STD. PENETRATION SAMPLE NO.	BLOWS/6 IN. THREE 6 IN. INCREMENTS	RECOVERY, %	SHELBY TUBE NO.	BORING AND SAMPLING NOTES
Brown moist SANDY CLAY							
		5	1	2 1/3	25		
	7.0						
Gray SANDY SILT with Gravel and sand seams (5'0 thick)		10	2	6 9/10	75		
		15	3	11 19/29	100		
		20	4	19 32/35	100		
		25	5	29 47/50 0.4	50		Set observation well @28.5'
Bottom test boring @ 28.8'			6	50 0.3	100		

WATER LEVEL OBSERVATIONS
NOTED ON RODS 13 FT.
AT COMPLETION FT.
AFTER ___ HRS FT

BORING METHOD
HSA – HOLLOW STEM AUGER
CFA – CONTINUOUS FLIGHT AUGER
DC – DRIVEN CASING
MD – MUD DRILLING
RC – ROCK CORING
CA – CASING ADVANCER

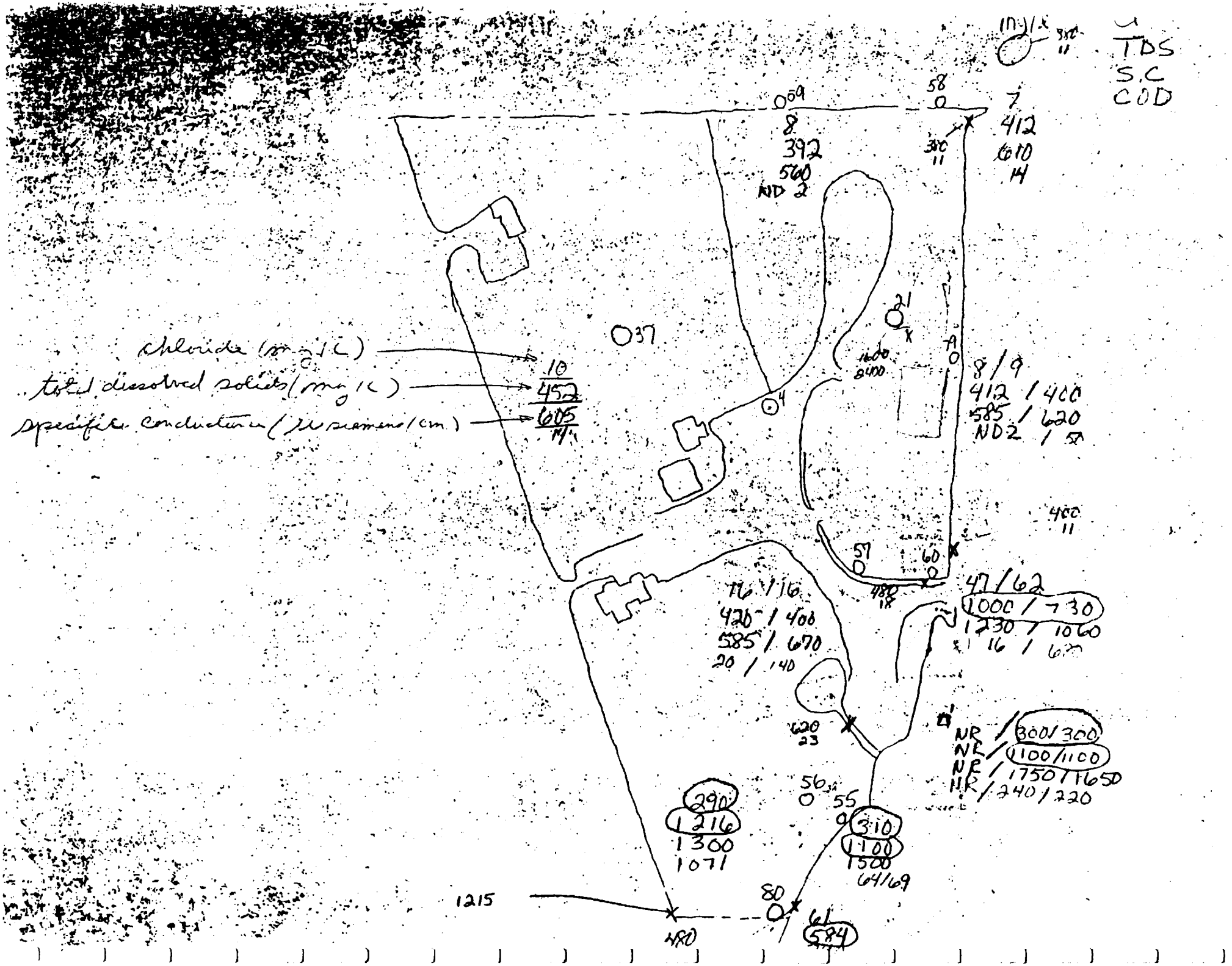
*THESE SHELBY TUBE SAMPLES OBTAINED IN AN AUXILIARY BORING DRILLED A FEW FEET FROM THIS BORING

FIG 5 - NORTH - SOUTH SECTION, SOUTH OF ACCESS ROAD TO AREA NORTH OF ECC SITE



APPENDIX III

The concentration of chloride and total dissolved solids and the specific conductance in groundwater samples collected from monitoring wells in the vicinity of the ECC-Site. The data were tabulated by personnel of the Indiana Department of Public Health from analyses on groundwater samples collected in late fall and early winter, 1983.


chloride (mg/l)
total dissolved solids (mg/l)
specific conductance (micromhos/cm)
10
452
605
1215
TDS
S.C
COD

APPENDIX B

BORING LOGS

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
W65230.C3	ECC-1A	1 OF 2

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION NORTHWEST CORNER

ELEVATION 887.20 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME 550 RIG, HSA TO 36', 6" O.D., 3¾" I.D.

WATER LEVEL AND DATE 6.5'-6/1/83-1440 HRS START 6/1/1983 FINISH 6/2/83 LOGGER D.W. LOVELL

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS: BLOWS PER 6 INCHES	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
2		SS-1	18"	2-3-5-5	SANDY SILTY CLAY, BROWN AND BLACK, MOIST, TOPSOIL WITH GRASS ROOTS (cl) 1.0'		
4		SS-2	14"	3-3-3-6	SILTY CLAY, MOTTLED BROWN AND GRAY, MOIST, MEDIUM STIFF, TRACE SAND (CL)		
6		SS-3	12"	7-12-18-23			
8		SS-4	15"	9-14-18-19	7.5'		
10		SS-5	18"	5-8-9-12	SILTY CLAY, GRAY, MOIST, MEDIUM STIFF, SOME SAND (cl) 11.5'		
12		SS-6	21"	5-7-8-13			SATURATED SOIL AT 11.5'
14		SS-7	18"	4-5-7-7	SILTY SAND, FINE, GRAY, WET, MEDIUM DENSE (SM) 12.5'		
16		SS-8	12"	3-7-16-14	SILTY CLAY, GRAY, WET, MEDIUM STIFF, TRACE SAND (CL-ML) 17.0'		
18		SS-9	22"	4-6-4-5			
20		SS-10	21"	3-4-7-9	SILTY CLAY, GRAY, WET, SOME SAND, MEDIUM STIFF TRACE GRAVEL (cl)		
22							
24	24.5				25.0'		
26	26.0	SS-11	16"	11-18-22	SAND, FINE TO MEDIUM, GRAY, MOIST TO WET, DENSE (SP-SW) 28.0'		SAND FLOWING INTO BOTTOM OF HOLLOW-STEM-AUGER
28	29.5						WATER LEVEL RISING TO ~6 FT BELOW GROUND SURFACE
30		SS-12	11"	6-8-10	SILTY CLAY, MOTTLED TAN AND BROWN, MOIST TO WET, STIFF (CL-ML)		

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
W65230.C3	ECC-1A	SHEET 2 OF 2

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION NORTHWEST CORNER

ELEVATION 887.20 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME 550 RIG, HSA TO 36', 5½" ROTARY BIT TO 40'

WATER LEVEL AND DATE 3.5'-6/2/83-0900 HRS START 6/1/83 FINISH 6/2/83 LOGGER D.W. LOVELL

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS: BLOWS PER 6-INCHES	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
32							
					33.5'		
34	34.5				SILTY CLAY, BROWN-GRAY,		
		SS-13	10"	25-41-57/3"	MOIST, SOME SAND, TRACE		PUSHED 6" CASING TO ~22 FT. THEN DROVE CASING W/300# HAMMER TO ~29 FT. DRILLED W/5½" ROTARY BIT FROM 36 TO 40 FT.
36	35.7				GRAVEL, HARD		
					(CL)		
38							
					BOTTOM OF BORING @ 40.0'		
40							SET MONITORING WELL TIP AT 28.5 FT.

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
W65230.C3	ECC-1C	SHEET 1 OF 6

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION NORTHWEST CORNER

ELEVATION 886.70 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME-550 RIG. HSA TO 8', ROTARY BIT W/CLEAR WATER TO 30'

WATER LEVEL AND DATE 3.9'-6/3/83-0800HRS START 6/2/83 FINISH 6/3/83 LOGGER I.H. JOHNSON

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS: BLOWS PER 6-INCHES	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
2					NOT SAMPLED FROM 0' TO 23.5'		OFFSET AND DRILLED WITHOUT SAMPLING TO 23.5 FT - SEE ECC-1A LOG FOR SHALLOW SOIL UNITS
4							
6							
8							
10							SET HSA'S TO 8' THEN PUSHED 6" CASING TO 8'
12							
14							
16							
18							
20							
22							
23.5					~23.5		HOLE CAVED BELOW 23.5'
24		SS-1	18"	6-10-13	SAND, FINE TO COARSE, GRAY, WET, MEDIUM DENSE, SOME FINE GRAVEL (SW)		PUSHED 6" CASING TO 18' DROVE 6" CASING TO 30' WITH 300# HAMMER
25.0							
26							
28							

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
W65230.C3	ECC-1C	2	6

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION NORTHWEST CORNER

ELEVATION 886.70 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME-550 RIG, 3½" DRAG BIT, BENTONITE MUD BELOW 30'

WATER LEVEL AND DATE 9.33'-6/4/83-0600 HRS START 6/2/83 FINISH 6/3/83 LOGGER I. H. JOHNSON

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS: BLOWS PER 6-INCHES	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
30	29.5				SAND, FINE, GRAY, WET, DENSE, SOME SILT (SM)		SET 4" CASING TO 30' INSIDE OF 6" CASING, THEN DROVE 4" CASING TO 34'
	30 – 31.0	SS-2	10"	14-16-18			
32					32.5'		VERY HARD DRILLING BELOW 32.5'
34	34.5				SILTY CLAY, GRAY, MOIST, HARD, SOME SAND, TRACE GRAVEL (CL-ML)		
	34 – 36.0	SS-3	14"	27-52-55			
36							
38	39.5				CLAY, GRAY, MOIST, HARD, WITH FINE TO COARSE SAND AND FINE GRAVEL (CL)		
40		SS-4	17"	26-32-60			
42	41.0						
44	44.5				SILTY CLAY, GRAY, MOIST, HARD, TRACE SAND (cl)		
	44 – 46.0	SS-5	16"	28-39-60			
46							
48	49.5						
50		SS-6	18"	13-21-25	CLAY, GRAY, MOIST, HARD, TRACE SAND (cl)		
52	51.0						
54	54.5				SILTY CLAY, MOTTLED GRAY AND BROWN, MOIST, HARD, TRACE SAND (CL-ML)		
	54 – 56.0	SS-7	18"	16-24-29			
56							
58	56.0						

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
W65230.C3	ECC-1C	3	6

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION NORTHWEST CORNER

ELEVATION 886.70 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME 550 RIG, ROTARY WITH BENTONITE MUD BELOW 30'

WATER LEVEL AND DATE 2.3' - 6/5/83 - 0630 HRS START 6/2/83 FINISH 6/8/83 LOGGER I.H. JOHNSON

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS: BLOWS PER 6-INCHES	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
60	59.5'				SILTY CLAY, BLUE-GRAY, MOIST TO WET, HARD (CL)		
	61.0	SS-8	12"	11-17-29	60.5'		
62	62.0	SS-9	18"	18-13-19	SAND, FINE TO COARSE, GRAY, WET, DENSE (SP) 62.5'		
64	63.5						
	64.5	SS-10	13"	25-52	SILTY CLAY, GRAY, MOIST, HARD, SOME FINE TO COARSE SAND (CL)		
66	65.5						
68							
	69.5						
70		SS-11	12"	46-57	SILT, GRAY, MOIST, HARD, TRACE CLAY, TRACE SAND (ml)		
	70.5						
72							
74	74.5						
		SS-12	12"	30-24-30	SILT, BROWN, MOIST, HARD, WITH FINE TO COARSE SAND AND FINE GRAVEL (ML)		
76	76.0						
78							
	79.5						
80		SS-13	11"	46-60/5"	SILT, BROWN, MOIST, HARD WITH FINE TO COARSE SAND AND FINE GRAVEL (ML)		
	80.5						
82							
84	84.5						
		SS-14	18"	23-31-45	SILT, BROWN, MOIST, HARD, TRACE FINE SAND (ml)		
86	86.0						
88							

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
W65230.C3	ECC-1C	4 OF 6

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION NORTHWEST CORNER

ELEVATION 886.70 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME 550 RIG, ROTARY WITH BENTONITE MUD BELOW 30'

WATER LEVEL AND DATE 2.7'-6/7/83-0715 HRS START 6/2/83 FINISH 6/8/83 LOGGER I.H. JOHNSON

ELEVATION / DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS (~~6"-6"-6"~~ ~~TNT~~ BLOWS PER 6-INCHES)	SOIL DESCRIPTION (NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL)	SYMBOLIC LOG	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION)
90	89.5						
		SS-15	18"	16-20-28	SILTY CLAY, BROWN-GRAY, MOIST, VERY STIFF, TRACE SAND AND FINE GRAVEL (cl)		
92	91.0						
94	94.5						
		SS-16	18"	24-42-60	SILTY CLAY, DARK GRAY, MOIST, HARD, TRACE SAND, TRACE FINE GRAVEL (cl)		EASIER DRILLING - FEWER COBBLES NOTICED BELOW 96'
96	96.0						
98							
	95.5						
100		SS-17	5"	60/5"	CLAYEY SILT, BROWN-GRAY, MOIST, HARD, SOME SAND, TRACE FINE GRAVEL (cl-ml)		ROUGH DRILLING COBBLES BELOW 120'
	100.0						
102							
104	104.5						
		SS-18	11"	37-60/5"	SILT, DARK GRAY, MOIST, HARD TRACE CLAY, TRACE FINE GRAVEL (ml) ~106.5		
106	105.5						EASIER DRILLING BELOW 106.5'
108					SAND, FINE, BROWN, WET, DENSE (sp) 110.0		
	109.5						
110		SS-19	18"	39-36-46	SILTY CLAY, BROWN, MOIST TO WET, HARD, TRACE SAND (cl)		
	111.0						
112							
114	114.5						
		SS-20	11"	38-60/5"	SILT, GRAY, MOIST, HARD, SOME SAND, SOME FINE GRAVEL (ml)		COBBLES AT ~116'
116	115.5						
118							

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
W65230.C3	ECC-1C	SHEET 5 OF 6

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION NORTHWEST CORNER

ELEVATION 886.70 DRILLING CONTRACTOR MATECO DRILLING CO

DRILLING METHOD AND EQUIPMENT CME 550 RIG, ROTARY WITH BENTONITE MUD BELOW 30'

WATER LEVEL AND DATE _____ START 6/2/83 FINISH 6/3/83 LOGGER I. L. JOHNSON

ELEVATION	DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS (BLOWS PER 6-INCHES)	SOIL DESCRIPTION (NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL)	SYMBOLIC LOG	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION)
		119.5						
120			SS-21	4"	60/4"	SILTY CLAY, MOTTLED BROWN AND GRAY, MOIST, HARD, SOME SAND, TRACE FINE GRAVEL (cl)		ROUGH DRILLING BELOW 120'
		120.0						
122								
		124.5						
124			SS-22	5"	60/5"	CLAYEY SILT, BROWN-GRAY, MOIST, HARD, SOME SAND TRACE FINE GRAVEL (cl-ml)		
		125.0						
126								
128								
		129.5						
130			SS-23	2"	60/4"	CLAYEY SILT, DARK GRAY, MOIST HARD, SOME SAND, TRACE FINE GRAVEL (cl-ml)		ROUGH DRILLING RUD CHATTER
		130.0						
132								
134		134.5						
			SS-24	2"	60/5"	SILT, GRAY, MOIST TO WET, TRACE FINE GRAVEL (ml)		
		135.0						
136								
138								
		139.5						
140			SS-25	18"	22-25-31	SILTY CLAY, BLUE-GRAY, MOIST VERY STIFF, TRACE SAND (CL)		EASIER DRILLING BELOW 139'
		141.0						
142								
144		144.5						
						145.0'		
			SS-26	18"	20-40-47	SAND, FINE, WET, DENSE, TRACE SILT (sp)		
146		146.0						
148								

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
W65230.C3	ECC-1C	SHEET 6 OF 6

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION NORTHWEST CORNER

ELEVATION 886.70 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME 550 RIG, ROTARY WITH BENTONITE MUD BELOW 30'

WATER LEVEL AND DATE _____ START 6/2/83 FINISH 6/8/83 LOGGER I.H. JOHNSON

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS (BLOWS PER 6 INCHES)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	149.5						
150		SS-27	11"	54-60/5"	CLAYEY SAND, GRAY, WET, DENSE WITH WEATHERED LIMESTONE FRAGMENTS (SC)		ROD CHATTER AND VERY DIFFICULT DRILLING BELOW 150'
	150.5						
152							
154	154.5						
		SS-28	12"	54-40-40	SILTY SAND, FINE TO COARSE, GRAY, WET, DENSE, SOME FINE GRAVEL (SM-SW)		
156	156.0						
158							PROBLEMS WITH HOLE CAVING FROM 157 TO 159'
	159.5						
160		SS-29	7"	26-40-69	GRAVEL, FINE TO MEDIUM, GRAY, WET, DENSE, WITH FINE TO COARSE SAND, TRACE SILT (GW-SW)		
	161.0						
162							PROBLEMS WITH HOLE CAVING
164					~165.0'		
	165.0				SILTY CLAY, GRAY, MOIST, SOFT		
	165.9	SS-30	10"	32-60/5"	(CL) TOP OF ROCK AT 166.0'		
166	166.0						REAMED HOLE WITH 5¼" ROLLER BIT, THEN SET 4" CASING TO 165'
168		NX ROCK CORE	4'10"	N.A.	LIMESTONE, LIGHT GRAY TO WHITE, HARD, UNWEATHERED, FRACTURED FROM 168.5-170'		
170							
	171.0				BOTTOM OF BORING 171.0'		

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
W65230.C3	ECC-2C	1 OF 6

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION NORTH

ELEVATION 886.94 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME-550 RIG, 3¾" I.D. HSA TO 36', ROTARY W/BENTONITE MUD BELOW 36'

WATER LEVEL AND DATE _____ START 6/13/83 FINISH 6/17/83 LOGGER B.N. ZVIRLEMAN

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS: BLOWS PER 6-INCHES	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0		SS-1	18"	7-3-2-3	SILTY CLAY, DARK BROWN, MOIST, SOME SAND, SOME ORGANICS, ROOTS AND GRASS (CL-OL) 1.0'		
2		SS-2	24"	4-6-10-14			
4		SS-3	24"	5-7-10-13	SILTY CLAY, GRAY, MOIST, STIFF, TRACE SAND, TRACE FINE GRAVEL (CL-ML)		
6		SS-4	20"	8-11-10-10			
8		SS-5	18"	4-5-7-9			
10		SS-6	20"	5-6-7-9			
12		SS-7	24"	3-4-6-8			
14		SS-8	19"	3-4-4-8	16.0'		WATER AT 15.0'
16		SS-9	15"	8-9-11-13	SAND, FINE TO COARSE, GRAY, WET, MEDIUM DENSE, GRADES TO FINE GRAVEL (SP)		
18		SS-10	24"	9-9-10-10	20.0'		
20		SS-11	10"	8-9-12-13	SAND, FINE TO COARSE, GRAY, WET, MEDIUM DENSE TO DENSE, SOME FINE GRAVEL (SW)		
22		SS-12	24"	11-11-13-19			
24		SS-13	0"	12-11-10-13			
26		SS-14	7"	10-10-12-17			
28		SS-15	0"	18-17-19-21			
30							

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET 2 OF 6
W65230.C3	ECC-2C	

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION NORTH

ELEVATION 886.94 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME 550 RIG, ROTARY WITH BENTONITE MUD BELOW 36'

WATER LEVEL AND DATE ____ START 6/13/83 FINISH 6/17/83 LOGGER B.N. ZVIBLEMAN

ELEVATION / DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS (~~6"-6"-6"~~ ~~INT~~ BLOWS PER 6-INCHES)	SOIL DESCRIPTION (NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL)	SYMBOLIC LOG	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION)
					31.5'		
32		SS-16	24"	29-18-17-22	SILTY SAND, FINE TO COARSE, GRAY, WET, DENSE (SM)		
34		SS-17	15"	20-16-18-26			SET 6" CASING TO 34'
		SS-18	16"	13-20-17-32	35.5'		SET 4" CASING TO 35'
36							
38	38.0	SS-19	12"	13-35-50	SILTY CLAY, GRAY, MOIST, VERY STIFF TO HARD, SOME FINE GRAVEL (cl-ml)		SET 4" CASING TO 39' HARD, SLOW DRILLING BELOW 40'
40	40.0						
42							
44	44.5	SS-20	18"	28-46-60	CLAY, GRAY, MOIST, VERY STIFF TO HARD, SOME FINE TO COARSE SAND (CL)		
46	46.0						
48	49.5						
50		SS-21	18"	20-26-39	CLAY, GRAY, MOIST, VERY STIFF TO HARD, SOME FINE TO COARSE SAND (CL)		
52	51.0						
54	54.5	SS-22	18"	27-24-23	CLAY, GRAY, MOIST TO WET, STIFF WITH 6" SILTY SAND LENS (cl and sm)		
56	56.0				~58'		
58							

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
W65230.C3	ECC-2C	3 OF 6

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION NORTH

ELEVATION 886.94 DRILLING CONTRACTOR MATTCO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME 55D RIG, ROTARY WITH BENTONITE MUD BELOW 36'

WATER LEVEL AND DATE _____ START 6/13/83 FINISH 6/17/83 LOGGER B.N. ZVIBLEMAN

ELEVATION / DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS (~~6-6-6~~ ~~INT~~ Blows per 6-inches)	SOIL DESCRIPTION (NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL)	SYMBOLIC LOG	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION)
60	59.5 – 61.0	SS-23	18"	12-16-24	SILT, OLIVE GREEN, MOIST, STIFF, SOME FINE SAND (ml)		
64	64.5 – 65.5	SS-24	11"	20-60/5"	SILTY SAND AND SANDY SILT, OLIVE GREEN, MOIST, STIFF TO HARD (sm and ml) ~68'		
72	69.5 – 70.5	SS-25	12"	37-60/5"	SILTY CLAY, OLIVE GREEN, MOIST, VERY STIFF TO HARD (cl)		
76	74.5 – 75.5	SS-26	12"	26-60/5"	CLAY, OLIVE GRAY, MOIST, HARD (cl)		
80	79.5 – 80.5	SS-27	12"	50-60/5"	CLAYEY SILT, OLIVE GRAY, MOIST, HARD (ML-CL)		
84	84.5 – 85.5	SS-28	11"	38-60/5"	SILTY CLAY, BROWN, DRY TO MOIST (cl)		

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
W65230.C3	ECC-2C	SHEET 4 OF 6

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION NORTH

ELEVATION 886.94 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME 550 RIG, ROTARY WITH BENTONITE MUD BELOW 36'

WATER LEVEL AND DATE _____ START 6/13/83 FINISH 6/17/83 LOGGER B.N. ZUBLEMAN

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS (~~6"-6"-6"~~ ~~INT~~ BLOWS PER 6-INCHES)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
89.5							
90		SS-29	18"	24-43-60/6"	SILTY CLAY, GRAY, MOIST, HARD, TRACE FINE GRAVEL (cl)		
91.0							
92							
94							
94.5							
96		SS-30	16"	28-49-60/4"	CLAY, GRAY, MOIST, HARD, SOME SILT (cl)		
96.0							
98					~98.0'		SOFTER DRILLING BELOW 98.0'
99.5							
100		SS-31	10"	55-60/5"	SAND, FINE TO COARSE, BROWN, VERY DENSE, TRACE FINE GRAVEL (SP-SM)		
100.5							
102							
104							
104.5							
106		SS-32	9"	43-60/3"	SAND, FINE TO MEDIUM, BROWN, VERY DENSE (sp)		
105.4							
108					~109.0'		
109.5							
110		SS-33	18"	20-44-56	SANDY SILT AND SILTY SAND, FINE, GRAY, WET (ml and sm)		
111.0							
112							
114					~114.0'		HARDER DRILLING BELOW 114.0'
114.5							
116		SS-34	18"	14-28-37	CLAYEY SILT, GRAY, MOIST, VERY STIFF (ml-cl)		
116.0							
118							

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
WG5230.C3	ECC-2C	5 OF 6

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION NORTH

ELEVATION 886.94 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME-550 RIG, ROTARY WITH BENTONITE MUD BELOW 36'

WATER LEVEL AND DATE _____ START 6/13/83 FINISH 6/17/83 LOGGER B.N. ZVIBLEMAN

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
119.5							
120		SS-35	18"	22-44-60/4"	SILTY CLAY, DARK GRAY, MOIST, HARD (CL)		
120.9							
122							
124							
124.5							
		SS-36	11"	34-60/5"	CLAY, GRAY, MOIST, HARD, TRACE FINE SAND (ch)		
126	125.5						ROD CHATTER DURING DRILLING FROM 126.0' TO 128.0'
128							
	128.5						
		SS-37	0"	60/5"			
130	129.9						
132							
134							
	134.5						
		SS-38	18"	42-56-54	CLAYEY SILT, GRAY, MOIST, HARD TRACE FINE SAND, TRACE ORGANICS (ROOTS) (ml-ol)		
136	136.0						
138							
	139.5						
140		SS-39	18"	12-15-21	CLAY, BLUE-GRAY, MOIST, VERY STIFF, TRACE SILT (cl)		
142	141.0						
144							
	144.5						
		SS-40	18"	25-17-24	CLAY, GRAY, MOIST, VERY STIFF, SOME FINE TO COARSE SAND (CL-ML)		
146	146.0						
148							

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET 6 OF 6
W65230.C3	ECC-2C	

SOIL BORING LOG

PROJECT ECC REMEDIAL INUESTIGATION LOCATION NORTH

ELEVATION 886.94 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME 550 RIG, ROTARY WITH BENTONITE MUD BELOW 36'

WATER LEVEL AND DATE _____ START 6/13/83 FINISH 6/17/83 LOGGER B.N. ZUIDLEMAN

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
					~149.0'		
149.5							
150		SS-41	18"	23-27-32	SAND, FINE TO MEDIUM, GRAY, WET, VERY DENSE, SOME LIMESTONE CHIPS (SM)		
151.0							
152							
154	154.5						
		SS-42	0"	60/4"			
154.9							
156							
158							
160	160.0				SAND, FINE TO COARSE, GRAY, WET, VERY DENSE, SOME FINE GRAVEL (SP-GP)		
		SS-43	4"	60/5"			
160.5							
162	162.5				TOP OF ROCK AT 162.5'		
		NX ROCK CORE	3'	N.A.	LIMESTONE, LIGHT GRAY TO WHITE, HARD, UNWEATHERED		
164					BOTTOM OF BORING 165.7'		
165.5							
166							

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
W65230.C3	ECC-3A	1 OF 1

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION SOUTHEAST CORNER

ELEVATION 876.60 DRILLING CONTRACTOR MATEC DRILLING CO.

DRILLING METHOD AND EQUIPMENT 3¼" I.D. Hollow Stem Augers, CME-45C TRAILER MOUNTED DRILL RIG

WATER LEVEL AND DATE 6'-6/14/83 - 8:50 AM START 6/14/83 FINISH 6/14/83 LOGGER I. H. JOHNSON

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS (BLOWS PER 6-INCHES)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
2'		SS-1	12"	7 4 2 6	SILTY CLAY, BROWN TO BLACK, DRY TO MOIST, STIFF, TRACE ORGANICS (CL)		
4'		SS-2	15"	3 3 4 4			
6'		SS-3	4"	2 4 7 6	6.0'		WATER AT 6.0' NOTED WHILE DRILLING WITH HOLLOW STEM AUGERS
8'		SS-4	12"	3 3 2 2	SAND, FINE TO COARSE, BROWN, WET, LOOSE TO MEDIUM DENSE, SOME SILT, TRACE FINE TO COARSE GRAVEL (SW-SM)		
10'		SS-5	18"	4 6 6 7			
12'		SS-6	24"	3 3 4 5			
14'		SS-7	24"	8 19 15 12			
16'		SS-8	24"	4 11 10 15			
18'		SS-9	20"	13 25 11 7	17.5'		
20'		SS-10	18"	5 7 9 13	SILTY CLAY, GRAY, MOIST, STIFF, TRACE FINE TO COARSE SAND (CL-ML)		
22'		SS-11	20"	5 10 13 19	21.5'		
24'		SS-12	24"	16 23 42 52	SILTY SAND, FINE TO MEDIUM, GRAY, MOIST, DENSE (SM)		
					23.5'		
					SILTY CLAY, GRAY, MOIST, HARD, SOME SAND, TRACE GRAVEL (CL)		
					24.0'		
					BOTTOM OF BORING AT 24.0'		

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
W65230.C3	ECC-3C	1 OF 6

SOIL BORING LOG

PROJECT ECC REMEDIAL INUESTIGATION LOCATION SOUTHEAST

ELEVATION 876.75 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME 550 RIG, ROTARY WITH BENTONITE MUD

WATER LEVEL AND DATE _____ START 6/22/83 FINISH 6/24/83 LOGGER B.N. ZUIDLEMAN

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS (BLOWS PER 6-INCHES)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
2							OFF-SET AND DRILLED WITHOUT SAMPLING TO 23.5' SEE ECC-3A LOG FOR SHALLOW SOIL UNITS
4							
6							
8							
10							
12							
14							
16							
18							
20							
22					23.5'		SET 4" CASING TO 23.5'
24							
26	27.0						
28		SS-1	0"	17-13-6 9/5"			
30	28.5						

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
W65230.C3	ECC-3C	2	6

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION SOUTHEAST

ELEVATION 876.75 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME 550 RIG, ROTARY WITH BENTONITE MUD

WATER LEVEL AND DATE _____ START 6/22/83 FINISH 6/24/83 LOGGER B.N. ZVIBLEMAN

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS (BLOWS PER 6-INCHES)	SOIL DESCRIPTION (NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL)	SYMBOLIC LOG	COMMENTS (DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION)
32							
34	34.5						
		SS-2	14"	16-41-47	SILTY CLAY, GRAY, MOIST, VERY STIFF TO HARD (CL-ML)		
36	36.0						
38							
	39.5						
40		SS-3	17"	20-22-28	SILTY CLAY, GRAY BROWN, MOIST, VERY STIFF TO HARD (cl-ml)		
	41.0						
42							
44	44.5						
		SS-4	18"	12-19-26	SILTY CLAY, DARK GRAY, MOIST, VERY STIFF (cl-ml)		
46	46.0						
48							
	49.5						
50		SS-5	18"	15-17-27	SILTY CLAY, MOTTLED OLIVE GREEN, MOIST, VERY STIFF TO HARD, TRACE SAND (cl-ml)		
	51.0						
52							
54	54.5						
		SS-6	18"	19-35-39	55.5'		
56	56.0				CLAY, OLIVE, MOIST, HARD, TRACE SAND, TRACE GRAVEL (cl)		
58							

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
W65230.C3	ECC-3C	3	6

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION SOUTHEAST

ELEVATION 876.75 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME 550 RIG, ROTARY WITH BENTONITE MUD

WATER LEVEL AND DATE _____ START 6/22/83 FINISH 6/24/83 LOGGER B.N. ZUIBLEMAN

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS: Blows per 6-inches	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
60	59.5						
		SS-7	11"	24-60/5"	CLAY, OLIVE, MOIST TO DRY, HARD, TRACE SILT (cl)		
	60.5						
62							
64	64.5						
		SS-8	17"	39-48-60/4"	SILTY CLAY, GRAY, MOIST, HARD, SOME FINE TO COARSE SAND, TRACE FINE GRAVEL (CL-ML)		
66	65.9						
68							
	69.5						
70		SS-9	11"	59-60/5"	SILT, OLIVE GRAY, DRY, HARD, TRACE FINE SAND (ml)		
	70.5						
72							
74	74.5						
		SS-10	11"	29-60/5"	CLAY, GRAY, DRY, HARD, TRACE SILT, TRACE FINE SAND (cl)		HARD SLOW DRILLING 76.0' - 79.0'
76	75.5						
78							
	79.5						
80		SS-11	17"	28-37-47	CLAYEY SILT, GRAY, MOIST, HARD, TRACE FINE SAND, TRACE FINE GRAVEL (cl-ml)		
	81.0						
82							
84	84.5						
		SS-12	18"	42-53-45	CLAYEY SILT, GRAY, MOIST, HARD, GRADES TO SILTY SAND, FINE, GRAY, DENSE, GRADES TO ORGANIC CLAY, BLACK TO DARK GRAY, HIGHLY PLASTIC, SOFT (ml) and (sm) and (ch-oh)		SOFT DRILLING 85-89.5' WOOD AND ORGANICS IN MUD RETURN
86	86.0						
88							

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET 4 OF 6
W65230.C3	ECC-3C	

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION SOUTHEAST

ELEVATION 876.75 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME 550 RIG, ROTARY WITH BENTONITE MUD

WATER LEVEL AND DATE: START 6/22/83 FINISH 6/24/83 LOGGER B.N. ZVIBLEMAN

ELEVATION / DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
90	89.5 – 91.0	SS-13	18"	31-43-44	CLAYEY SILT, GRAY, MOIST, HARD, TRACE FINE GRAVEL, GRADES TO SILTY SAND, FINE, GRAY, WET (ml-sm)		
92							
94	94.5 – 95.0	SS-14	5"	60/6"	SANDY SILT, DARK GRAY, MOIST, HARD, TRACE FINE GRAVEL (ml-sm)		
96							
98							
100	99.5 – 100.0	SS-15	0"	60/6"			
102							
104	104.5 – 106.0	SS-16	18"	32-48-43	CLAYEY SILT, GRAY, MOIST, HARD, TRACE FINE SAND (ML)		
106							
108							SOFTER DRILLING 108.0'-109.5'
110	109.5 – 109.9	SS-17	5"	120/5"	CLAYEY SILT, GRAY, MOIST, HARD TRACE FINE SAND (ml)		ROD CHATTER AT ~112'
112							
114	114.5 – 114.9	SS-18	2"	60/4"	SANDY SILT, GRAY, DRY, HARD, TRACE CLAY, TRACE ORGANICS (ml-sm)		HARD DRILLING 115.0'-119.0'
116							
118							

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
W65230.C3	ECC-3C	5 OF 6

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION SOUTHEAST

ELEVATION 876.75 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME 550 RIG, ROTARY WITH BENTONITE MUD

WATER LEVEL AND DATE _____ START 6/22/83 FINISH 6/24/83 LOGGER B.N. ZUILLEMAN

ELEVATION / DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
120	119.5 – 119.9	SS-19	5"	60/5"	SANDY SILT, GRAY, MOIST, HARD, TRACE FINE GRAVEL (ml-sm)		SOFTER DRILLING 119'-124'
122							
124	124.5				SILTY CLAY, BROWN, MOIST, HARD, TRACE FINE SAND AND GRAVEL (cl)		
126	126.0	SS-20	18"	32-39-51			SOFT DRILLING 125'-130'
128							
130	129.5	SS-21	18"	20-24-31	SILTY CLAY, BROWN, MOIST, HARD (CL)		
132	131.0						SOFT DRILLING 130'-135'
134	134.5	SS-22	18"	30-28-56	SILTY CLAY, BROWN, MOIST, HARD (cl) 135.5'		
136	136.0				SILTY SAND, FINE TO MEDIUM, GRAY, DENSE (sm)		
138							
140	138.5	SS-23	16"	33-44-60/4"	SAND, FINE, GRAY, MOIST, DENSE GRADES TO A SILTY SAND (sp-sm)		
142	140.9						
144	144.5	SS-24	0"	120/6"			HARD, SLOW DRILLING 147'-154'
146	145.0				~147.0'		
148							

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET 6 OF 6
W65230.C3	ECC-3C	

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION SOUTHEAST

ELEVATION 876.75 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME 550 RIG, ROTARY WITH BENTONITE MUD

WATER LEVEL AND DATE _____ START 6/22/83 FINISH 6/24/83 LOGGER B.N. ZUIDEMAN

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		149.5						
150			SS-25	18"	30-44-55	CLAY, GRAY-BROWN, MOIST, HARD (CL)		
		151.0						
152								
154						BOTTOM OF BORING 154.5		
						TOP OF ROCK		'NX' CORE BARREL BROKEN – COULD NOT GET WATER CIRCULATION TO CORE ROCK
156								

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
W65230.C3	ECC-4C	SHEET 1 OF 6

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION EAST

ELEVATION 884.62 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME-45 TRAILER MOUNTED RIG, 3¼" I.D. HOLLOW STEM AUGERS TO 26'

WATER LEVEL AND DATE 10.0'-6/14/83-1600 HRS START 6/14/83 FINISH 6/21/83 LOGGER B.N. ZVIBLEMAN

ELEVATION / DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS ~~0"-6"-6"~~ ~~INT~~ BLOWS PER 6-INCHES	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
2		SS-1	18"	5-4-4-7	FILL		
4		SS-2	20"	6-4-7-7	4.0'		
6		SS-3	16"	3-4-5-6	SILT, BLACK, SOME ORGANICS, TRACE SAND, MOIST (ml-ol) 5.5'		
8		SS-4	16"	4-5-9-11	CLAYEY SILT, GRAY, MOIST, STIFF, TRACE FINE TO COARSE SAND (ML) 9.5'		
10		SS-5	18"	7-12-12-10	SAND, FINE TO COARSE, GRAY, SOME CLAY (SC)		WATER AT 10.0'
12		SS-6	13"	10-14-20-18			
14		SS-7	12"	25-37-34-33	SAND, FINE TO COARSE, GRAY, SOME CLAY, GRADES TO SILTY SAND (SC)		
16		SS-8	13"	15-22-30-45			
18		SS-9	20"	30-33-40-47	17.0'		
		SS-10	11"	40-60/5"	SILTY CLAY, GRAY, MOIST, HARD, INTERBEDDED WITH SILTY FINE SAND (CL)		
	18.9						
20		SS-11	24"	25-33-30-32	21.5'		
22		SS-12	20"	18-22-24-32	CLAY, GRAY, MOIST, HARD, SOME FINE TO COARSE SAND (CL)		
24		SS-13	24"	17-23-26-30			
26							PULLED HOLLOW STEM AUGERS AND SET 4" CASING TO 25' STARTED DRILLING WITH 3¾" ROLLER BIT AND WATER
28							

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET 2 OF 6
W65230.C3	ECC-4C	

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION EAST

ELEVATION 884.62 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME 45 TRAILER MOUNTED RIG, 3 3/4" ROLLER BIT WITH BENTONITE 26'-70.5'

WATER LEVEL AND DATE _____ START 6/14/83 FINISH 6/21/83 LOGGER I.H. JOHNSON

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS (~~6" 6" 6"~~ ~~INT~~ Blows per 6-inches)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
30	29.5				CLAYEY SILT, GRAY, MOIST, HARD, SOME SAND, TRACE GRAVEL (ml-cl)		STARTED USING BENTONITE MUD WITH ROLLER BIT
		SS-14	9"	6-26-44			
32	31.0						VERY SLOW DRILLING
34	34.5				CLAYEY SILT, GRAY, MOIST, HARD, TRACE SAND, TRACE GRAVEL (ml-cl)		
		SS-15	14"	27-46-47			
36	36.0						
38							VERY SLOW DRILLING
	39.5				CLAY GRAY-BLUE, MOIST, HARD, SOME FINE TO COARSE SAND (CL)		
40		SS-16	15"	34-50-60/5"			
42	41.0						VERY SLOW DRILLING
44	44.5				SILTY CLAY, GRAY-BLUE, MOIST, HARD, TRACE SAND, TRACE GRAVEL (cl-ml)		
		SS-17	15"	17-27-38			
46	46.0						
48							VERY SLOW DRILLING
	49.5				SILTY CLAY, GRAY-BLUE, MOIST, HARD, TRACE SAND, TRACE GRAVEL (cl-ml) ~52.0'		
50		SS-18	18"	20-30-40			SWITCHED FROM 3 3/4" ROLLER BIT TO 3 1/2" DRAG BIT TO SPEED UP DRILLING THROUGH THE GLACIAL TILL
52	51.0						
					CLAY, OLIVE GREEN TO GRAY, MOIST, STIFF (CL) ~57.5'		
54	54.5						
		SS-19	18"	10-17-23			
56	56.0						
58							

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
W65230.C3	ECC-4C	3 OF 6

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION EAST

ELEVATION 884.62 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME-550 RIG, ROTARY WITH BENTONITE MUD BELOW 70.5'

WATER LEVEL AND DATE ____ START 6/14/83 FINISH 6/21/83 LOGGER I.H. JOHNSON

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS ~~6" 6" 6"~~ ~~INT~~ BLOWS PER 6-INCHES	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
59.5					SAND, FINE, BROWN TO GREEN, MOIST, DENSE (sp) 60.5'		
60	SS-20		18"	17-23-21			
61.0					SILTY CLAY, GRAY, MOIST, HARD (cl)		
62							
64	64.5						
	SS-21		11"	25-60/5"	SILTY CLAY, BROWN TO GRAY, MOIST, HARD, WITH FINE SILTY SAND LENSES (cl-ml)		
66	65.5						
68							
69.5							
70	SS-22		10"	30-60/5"	SAND, FINE, GRAY, MOIST, DENSE, SOME SILT (sp-sm)		STARTED USING CME-550 RIG AT 70.5'
70.5							
72							
74	74.5						
	SS-23		8"	50-60/2"	CLAYEY SILT, OLIVE-GRAY, DRY, HARD, TRACE SAND, TRACE GRAVEL (ml-cl)		
75.1							
76							BIT CLOGGED
78							
79.5							
	SS-24		0"	60/3"			
80	79.8						
82							
84	84.5						
	SS-25		12"	37-60/5"	CLAYEY SILT, GRAY, DRY TO MOIST, HARD, TRACE SAND (ml)		SLOW, HARD DRILLING
86	85.9						
88							

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET OF
W65	ECC-4C	4 OF 6

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION EAST

ELEVATION 884.62 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME 550 RIG, ROTARY WITH BENTONITE MUD BELOW 70.5'

WATER LEVEL AND DATE _____ START 6/14/83 FINISH 6/21/83 LOGGER B.N. ZUIDLEMAN

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS (~~6" 6" 6"~~ INT BLOWS PER 6-INCHES)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
90	89.5				SILTY CLAY, GRAY, MOIST, HARD, GRADES TO SILTY FINE SAND (cl-ml)		
		SS-26	14"	49-28-60/2"			
92	90.6						
94	94.5				CLAYEY SILT, GRAY, MOIST, HARD (ML)		
		SS-27	17"	49-53-60/5"			
96	95.9						
98							
100	99.5	SS-28	6"	60/6"	SANDY CLAY, DARK GRAY, MOIST, HARD, SOME SILT (SC)		
	100.0						
102							SLOW, HARD DRILLING 102.0' - 104.0'
104	104.5				SILTY CLAY, GRAY, MOIST, HARD, TRACE FINE SAND (cl)		
		SS-29	16"	31-33-60/4"			
106	105.9						
108							
110	109.5	SS-30	0"	60/5"			
	109.9						
112							
114	114.5				SANDY SILT, GRAY, MOIST, DENSE (ml-sm)		
		SS-31	11"	41-60/5"			
116	115.5						
118							

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
W65230.C3	ECC-4C	5 OF 6

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION EAST

ELEVATION 884.62 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME 550 RIG, ROTARY WITH BENTONITE MUD BELOW 70.5'

WATER LEVEL AND DATE _____ START 6/14/83 FINISH 6/21/83 LOGGER B.N. ZUIBLEMAN

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS: ~~6"-6"-6"~~ ~~INT~~ BLOWS PER 6-INCHES	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
120	119.5 – 119.8	SS-32	3"	60/3"	SILTY SAND, FINE, GRAY, MOIST, VERY DENSE, SOME CLAY (sm)		
124	124.5 – 124.9	SS-33	3"	60/3"	SILTY SAND, FINE, GRAY, MOIST, VERY DENSE (sm)		
130	129.5 – 129.9	SS-34	1"	60/4"	SANDY SILT, BROWN-GRAY, MOIST, VERY DENSE, TRACE CLAY (ml)		HARD DRILLING 130.0' TO 135.0'
134	134.5 – 136.0	SS-35	18"	27-36-48	SILTY CLAY, GRAY, MOIST, HARD (cl)		
140	139.5 – 141.0	SS-36	18"	22-26-31	SILTY CLAY, BROWN, MOIST, HARD, SOME SAND (cl)		
144	144.5 – 145.9	SS-37	17"	34-54-60/5"	SILTY CLAY, BROWN, MOIST, HARD, SOME SAND, OCCAS. SAND LENSES (cl)		

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
W65230.C3	ECC-4C	6 OF 6

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION EAST

ELEVATION 884.62 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME 550 RIG, ROTARY WITH BENTONITE MUD BELOW 70.5'

WATER LEVEL AND DATE _____ START 6/14/83 FINISH 6/21/83 LOGGER B.N. ZUIDLEMAN

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS: BLOWS PER 6-INCHES	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
					~149.0'		
	149.5						
150		SS-38	12"	31-47-60/5"	SAND, FINE, GRAY, WET, VERY DENSE, SOME SILT (SM)		
	150.9						
152							
154	154.5						
		SS-39	8"	53-60/5"	SAND, FINE TO COARSE, GRAY, WET, VERY DENSE, TRACE SILT (SM)		
156	155.5						
158							
160							SLOW DRILLING 160-162'
	161.0				CLAY, LIGHT GRAY, MOIST, HARD		
		SS-40	10"	34-60/4"	TOP OF ROCK ▼ 161.9'		
162	161.9						
	162.9				LIMESTONE, LIGHT GRAY TO WHITE, HARD, UNWEATHERED		
164		NX Rock Core	3.0'	N.A.			
					BOTTOM OF BORING ▼ 165.9'		
166	165.9						

REV 11/82 FORM D1586

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
W65230.C3	ECC-5A	SHEET 1 OF 2

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION SOUTHWEST

ELEVATION 887.28 DRILLING CONTRACTOR MATECO DRILLING

DRILLING METHOD AND EQUIPMENT CME 550 RIG, 3¾" HOLLOW STEM AUGERS

WATER LEVEL AND DATE 10.0' - 6/24/83 START 6/24/83 FINISH 6/24/83 LOGGER B.N. ZVIBLEMAN

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
2							
4	4.5						
		SS-1	24"	5-7-9-13	SILTY CLAY, MOTTLED BROWN AND GRAY, MOIST, VERY STIFF, TRACE OF ROOTS, TRACE GRAVEL (CL-ML)		
6	6.5						
8	9.5						
		SS-2	18"	7-4-4-4	SILTY CLAY, GRAY, WET, MEDIUM STIFF, WITH INTERBEDDED SILTY SAND AND SANDY SILT (cl-ml)		WATER AT 10' NOTED WHILE DRILLING WITH HOLLOW STEM AUGERS
10							
12	11.5						
14	14.5						
		SS-3	17"	5-6-7-9	CLAYEY SILT, GRAY, WET, STIFF, TRACE SAND (ml)		
16	16.5						
18					~18.0'		
	19.5						
20		SS-4	16"	6-6-6-8	SAND, FINE TO COARSE, GRAY, WET, MEDIUM DENSE, SOME FINE GRAVEL (SW)		HARDER DRILLING BELOW 22'
22	21.5						
24	24.5						
		SS-5	0"	12-15-19-19			
26	26.5						
28							

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET 2 OF 2
W65230.C3	ECC-5A	

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION SOUTHWEST

ELEVATION 887.28 DRILLING CONTRACTOR MATECO DRILLING CO.

DRILLING METHOD AND EQUIPMENT CME 550 RIG, 3¾" I.D. HOLLOW STEM AUGER

WATER LEVEL AND DATE _____ START 6/24/83 FINISH 6/24/83 LOGGER B.N. ZUIDEMAN

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
30	29.5	SS-6	22"	13-20-27-30	SAND, FINE TO COARSE, GRAY, WET, VERY DENSE, GRADES TO FINE SILTY SAND (SW-SM)		
32	31.5				BOTTOM OF BORING AT 31.5'		

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET / OF 1
W65230.C3	ECC-6A	

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION NORTHEAST

ELEVATION _____ DRILLING CONTRACTOR ATEC, ASSOC.

DRILLING METHOD AND EQUIPMENT 3¼" I.D. HSA's TO 28.5' 6¼" I.D. HSA's TO 23.0'

WATER LEVEL AND DATE 8.5' - 09:25 HRS 9/1/83 START 0815- 9/1/83 FINISH 1735- 9/1/83 LOGGER J. H. JOHNSON

ELEVATION / DEPTH BELOW SURFACE	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
5.0		SS-1	18"	2-4-6	CLAYEY SILT, MOTTLED BROWN, MOIST, STIFF, 10% FINE SAND (ML-CL)		START 0815 HRS STARTED SAMPLING AT 5' BELOW GROUND SURFACE
		SS-2	18"	8-11-12	8.0'		
		SS-3	18"	5-6-8	SILTY CLAY, GRAY, MOIST, STIFF, 10% FINE TO MED. SAND (CL)		
10.0		SS-4	18"	4-5-7			
		SS-5	12"	4-5-8			
		SS-6	18"	10-11-11	13.5'		Water Noted at 13.5' ON SS-6 (09:20 HRS)
15		SS-7	18"	2-2-2	SAND, FINE TO COARSE, GRAY, WET, MED. DENSE TO DENSE, ~10 % FINE GRAVEL, (SP)		Water Noted at 8.5' ON AW-RODS (09:25 HRS)
		SS-8	18"	7-7-10			
		SS-9	18"	8-22-48			
		SS-10	6"	9-15-20			
20							
	23.5						
		SS-11	18"	15-27-21	24.5		
25	25.0				SILTY CLAY, GRAY, MOIST, HARD, 10% SAND, (CL-ML)		NO HNU READINGS ABOVE BACKGROUND
	28.5						
		SS-12	12"	33-50-4-3	BOTTOM OF BORING 30.0		
30							

CH2M HILL

PROJECT NUMBER	BORING NUMBER	SHEET
W65230.C3	ECC-7A	1 OF 1

SOIL BORING LOG

PROJECT ECC REMEDIAL INVESTIGATION LOCATION SOUTH OF ECC-4

ELEVATION _____ DRILLING CONTRACTOR ATEC, PSSOC.

DRILLING METHOD AND EQUIPMENT 3¼ HSA's TO 29.5 FT. BELOW GROUND SURFACE

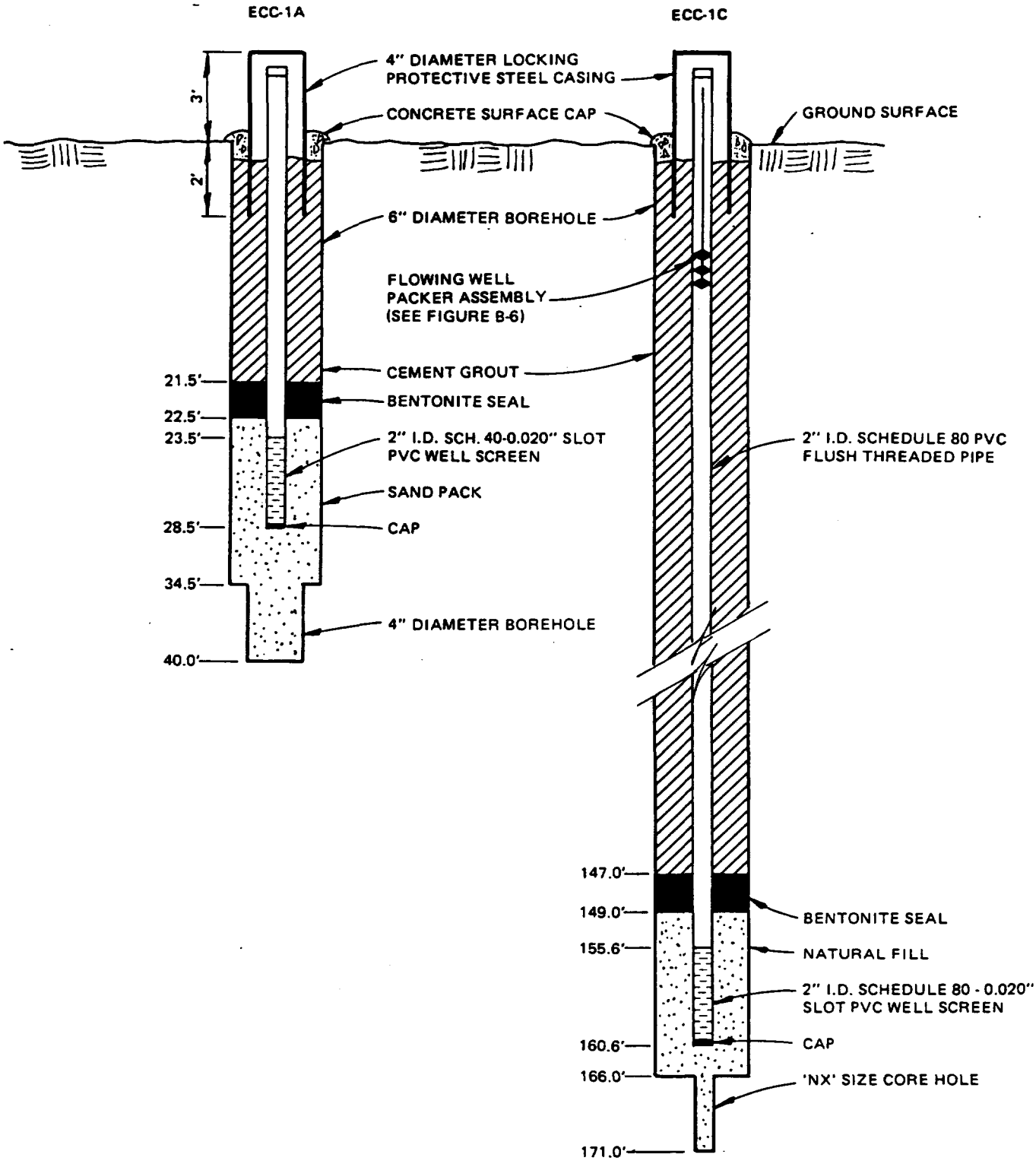
WATER LEVEL AND DATE 12.5 FT - 9/1/83 START 9/1/83-1630 FINISH 9/1/83-1810hrs LOGGER I. H. JOHNSON

ELEVATION / DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
					FILL, ~~SAND~~, SILT, CLAY, MOTTLED BROWN, SOME TRASH		DRILLED TO 5.0 FT TO START SPLIT-SPOON SAMPLING
					4.0'		
5					SILTY CLAY, MOTTLED GREEN, MOIST, STIFF, (CL)		
		SS-1	10"	2-5-9	6.5'		
		SS-2	12"	10-13-14	CLAYEY SILT, GRAY, MOIST, STIFF TO HARD, (CL-ML)		
		SS-3	12"	13-16-21			
10		SS-4	9"	16-19-20			
		SS-5	11"	17-30-28	12.0'		
		SS-6	16"	12-17-18	SILTY SAND, FINE, GRAY, WET, DENSE, (SM) 13.0'		
15		SS-7	18"	11-20-27	CLAYEY SILT, GRAY, MOIST, HARD, WITH INTERBEDDED, SILTY SAND, FINE, GRAY, MOIST TO WET, DENSE (ML-CL) AND (SM)		WATER NOTED AT 15.5' ON RODS
		SS-8	18"	18-19-35			
		SS-9	18"	4-28-46			
		SS-10	14"	20-29-21			
20							
		SS-11	18"	17-30-39	CLAYEY SILT, GRAY, MOIST, HARD, ~10 TO 15% SAND, (ML-CL)		
25							NO HNu READINGS ABOVE BACKGROUND
					SILTY SAND, FINE, GRAY, WET, (SM)		WATER AT 12.5 FT. AT COMPLETION
		SS-12	9"	49-65/6"	BOTTOM OF BORING @ 29.5'		
30							

REV 11/82 FORM D1586

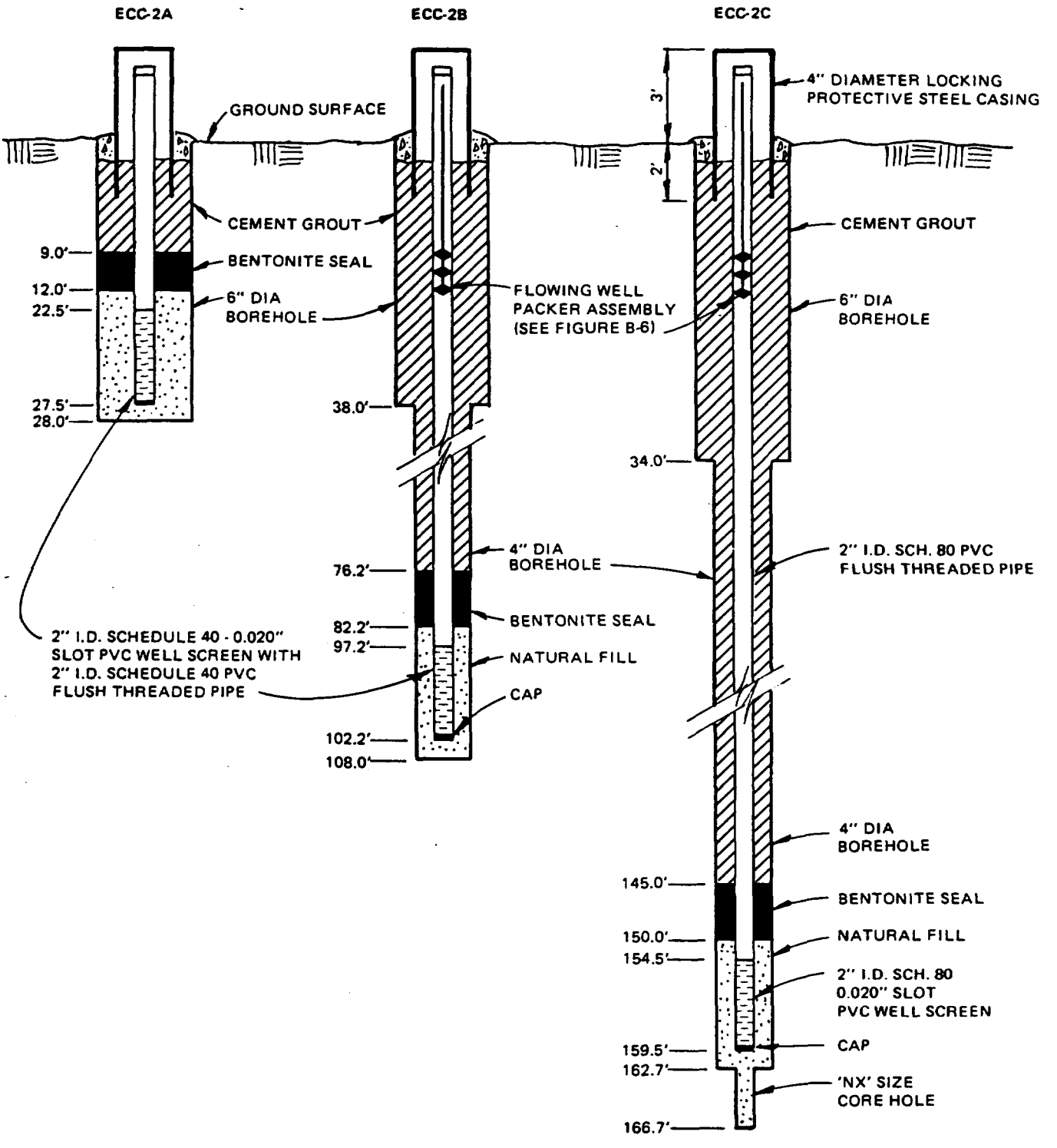
APPENDIX C

MONITORING WELL CONSTRUCTION DETAILS



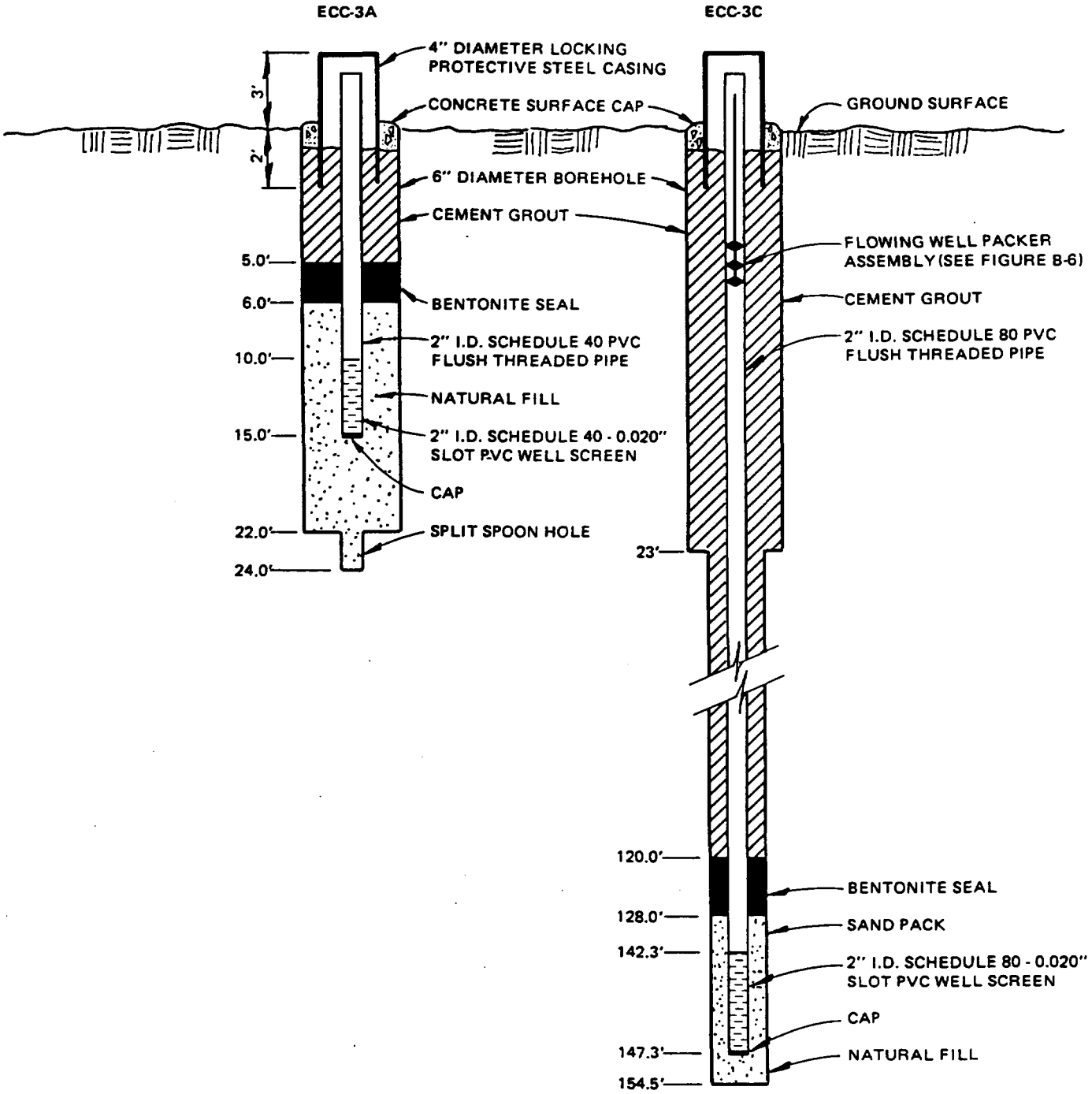
NOTE: Figure not drawn to scale

FIGURE B-1
MONITORING WELL CONSTRUCTION
ECC-1 CLUSTER
TM 3-1



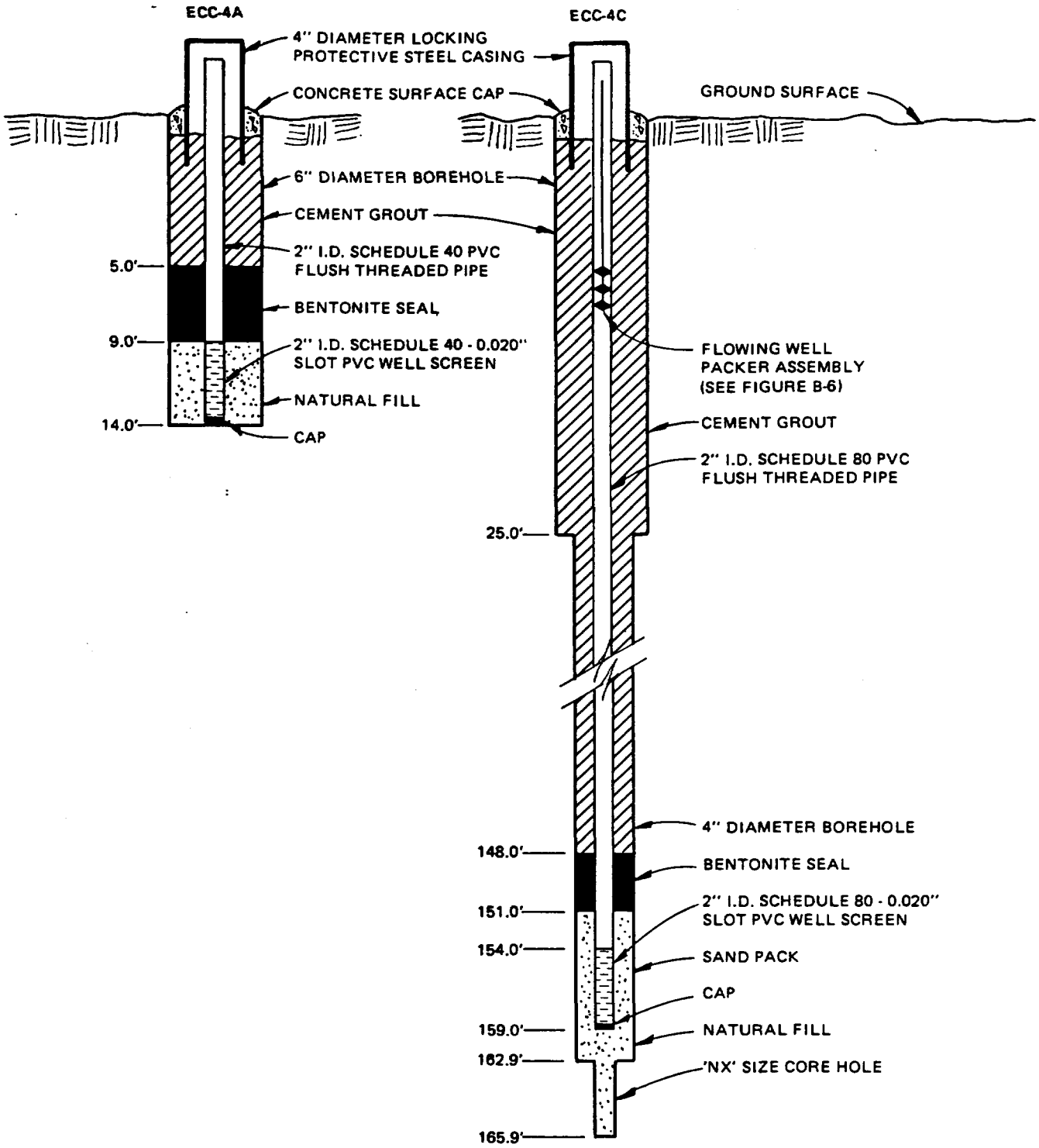
NOTE: Figure not drawn to scale

FIGURE B-2
MONITORING WELL CONSTRUCTION
ECC-2 CLUSTER
TM 3-1



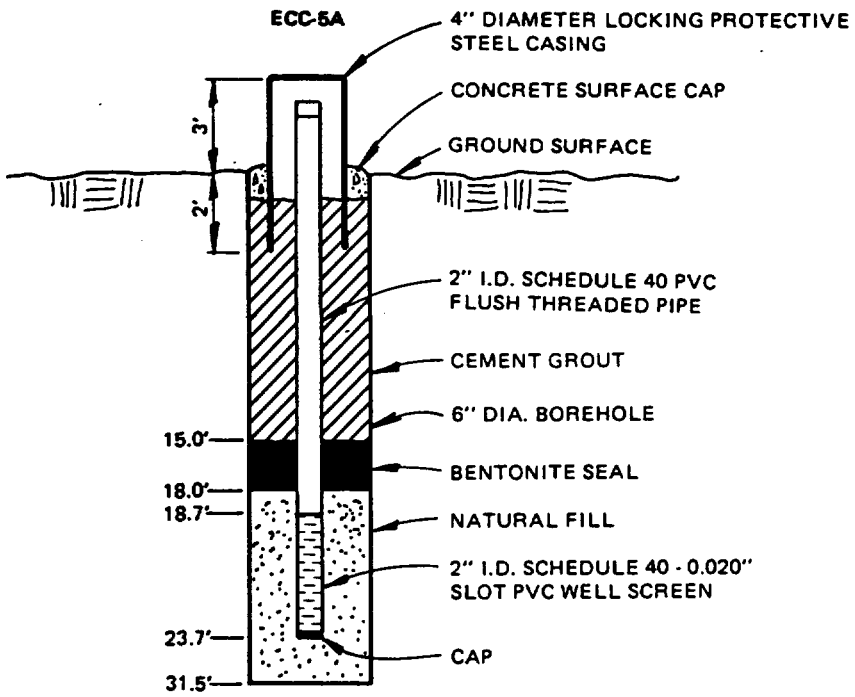
NOTE: Figure not drawn to scale

FIGURE B-3
MONITORING WELL CONSTRUCTION
ECC-3 CLUSTER
TM 3-1



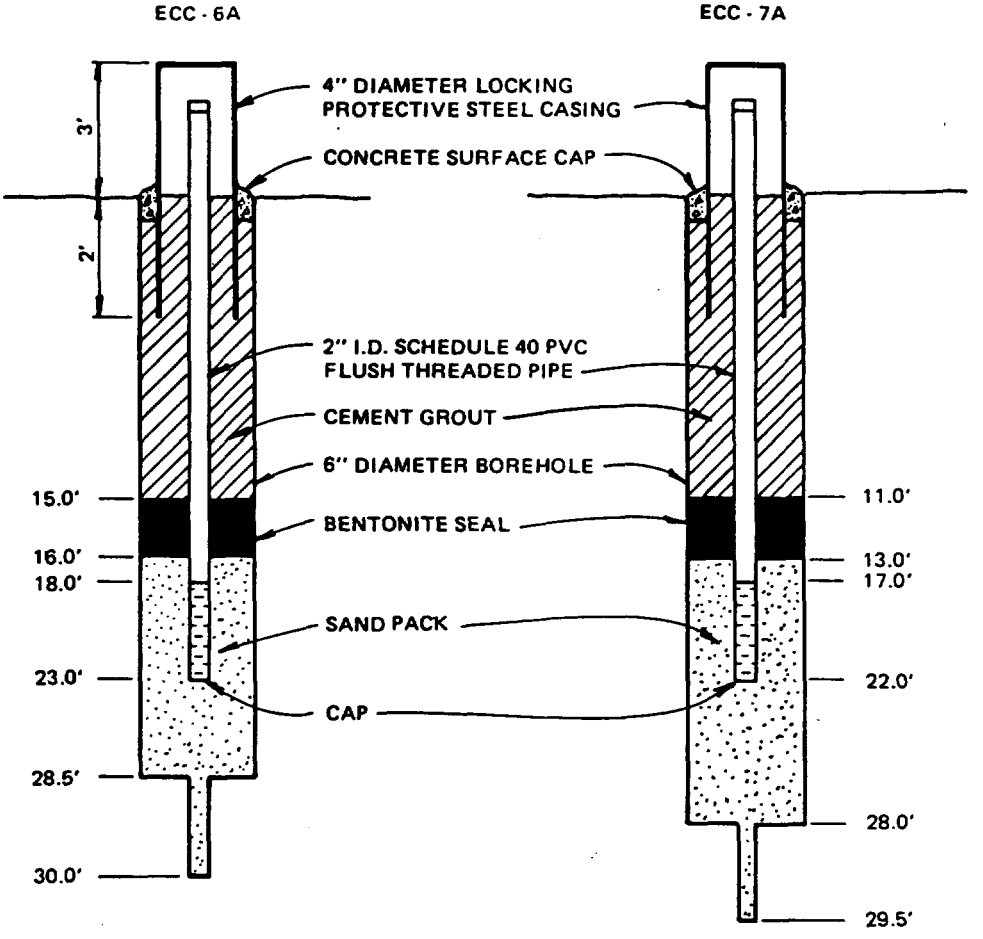
NOTE: Figure not drawn to scale

FIGURE B-4
MONITORING WELL CONSTRUCTION
ECC-4 CLUSTER
TM 3-1



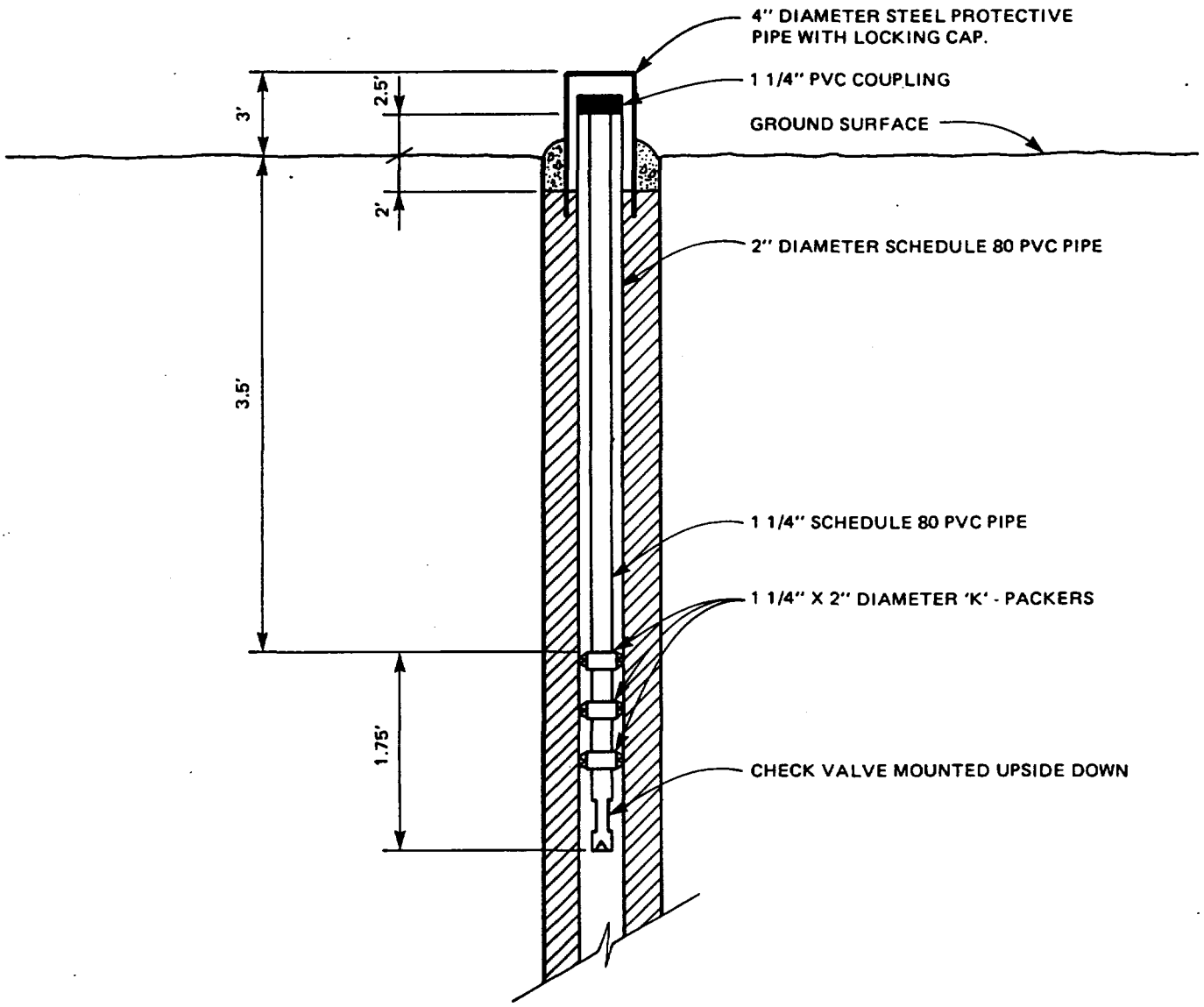
NOTE: Figure not drawn to scale

FIGURE B-5
MONITORING WELL CONSTRUCTION
ECC-5A
TM 3-1



NOTE: Figure not to scale.

FIGURE B-6
MONITORING WELL CONSTRUCTION
ECC - 6A AND ECC - 7A
ECC SITE
TM 3-1



NOTE: 2", 4" and 6" galvanized nipples used to connect K - Packers and check valve.

FIGURE B-7
TYPICAL FLOWING WELL PACKER SYSTEM INSTALLATION
ECC SITE
TM 3-1

APPENDIX D

LABORATORY SOIL CLASSIFICATION TEST RESULTS

LABORATORY TESTING PROCEDURES

Grain Size Tests

Grain size tests were performed to determine the particle size and distribution of the samples tested. The grain size distribution of soils coarser than a No. 200 sieve was determined by passing the sample through a standard set of nested sieves. These tests are similar to those described by ASTM D-421 and D-422. The results are presented on the attached Grain Size Distribution Sheets.

Moisture Content

The moisture content is the ratio expressed as a percentage of the weight of water in a given mass of soil to the weight of the solid particles. This test was conducted in accordance with ASTM Designation D-2216-66. The results of these tests are presented on the attached Summary of Laboratory Test Data.

Specific Gravity of Soil Solids

The specific gravity of soil solids is the ratio of the weight in air of a given volume of soil particles to the weight in air of an equal volume of water. This test was conducted on selected soil samples in accordance with ASTM designation D-854-58. The results of these tests are presented on the attached Summary of Laboratory Data.

Atterberg Limits Testing

Representatiave samples of the soils were selected for Atterberg Limits testing to determine the soil plasticity characteristics. The soil's Plastic Index (PI) is representative of this characteristic and is bracketed by the Liquid Limit (LL) and the Plastic Limit (PL). The LL is the moisture content at which the soil will flow as a heavy viscous fluid and is determined in accordance with ASTM D-423. The PL is the moisture content at which the soil begins to lose its plasticity and is determined in accordance with ASTM D-424. The data obtained are presented on the attached Summary of Laboratory Test Data and boring logs.

BORING LOG TERMINOLOGY

Permit Number:	This mineral Well Permit Number is assigned to Materials Testing Consultants, by the State of Michigan Department of Natural Resources Geological Survey Division. Materials Testing Consultants is obligated under the rules of the Mineral Well Act to plug test borings in a specified manner.
Sample Type:	"SBS" and "L" are the split barrel and liner samplers used to recover soil samples in the ASTM D 1586 Standard Penetration Test. "S.T." refers to the thin-walled sampler (Shelby Tube) used to recover relatively undistrubed soil samples in the ASTM D 1587 method of sampling. "A" refers to a distrubed auger sample. "C" refers to a rock core sample obtained by Diamond Core Drilling in accordance with ASTM D 2113.
Boring Method:	"H.S.A." refer to the Hollow Stem Auger. "S.S.A." refers to the Solid Stem Auger. "W" refers to the Wash Boring Method. "R" refers to the Rotary Method. "C" refers to the Casing Method.
Water Observations:	Depth of water is measured from the top of ground to top of water level. Initial depth indicates water encountered during boring, completion depth indicates water level immediately after boring, and depth after "X" number hours indicates water level after a time period. Water observations in pervious soils are considered reliable groundwater levels for that date. Water observations in impervious soils may not be accurate groundwater measurements unless records are made over several days' time. The groundwater level will fluctuate for both pervious and impervious soils.
Soils Description:	Visual classification of major soil constituents.

Color: When the color of the soil is uniform throughout, a single color such as brown, gray or black will be used, modified by adjective such as light and dark. If the soil's predominant color is shaded by a secondary color, the secondary color precedes the primary color, such as: gray-brown, yellow-brown. If two major and distinct colors are swirled throughout the soil, the colors will be described by the term mottled, such as: Mottled brown and gray.

Size:

Soil Components	Size
Boulders	Larger than 8"
Cobbles	8" to 3"
Gravel--Coarse	3" to 3/4"
--Fine	2 mm. to 3/4"
Sand --Coarse	2 mm. to 0.6 mm.
--Medium	0.6 mm.-0.2 mm.
--Fine	0.2 mm.-0.06 mm.
Silt	0.06 mm.-0.002 mm.
Clay	0.002 mm and smaller

Minor Component Quantifying Term:

Trace	1-10%	(Percentages are estimates unless a sieve analysis is performed
Little	10-20%	
Some	20-35%	
And	35-50%	

Layer or Stratum: Soil mass which can be characterized, for engineering purposes, by a single set of strength and classification parameters.

Lenses: Lenses of soil occur within a soil layer and range in thickness from a fraction of an inch to approximately one (1) foot thick.

Seams: Planer opening in a soil layer filled with soils of different characteristics. Soil seams are usually a fraction of an inch thick and may occur in various directions.

Density:
Granular Soils (Cohesionless)

Number of Blows	Relative Density	Compactness
0-4	0-20%	Very Loose
5-10	20-40%	Loose
11-30	40-70%	Medium Dense
31-50	70-90%	Dense
above 50	90-100%	Very Dense

Consistency:
Cohesive Soils

Number of Blows	Approximate Shear Strength in K.S.F.	Cohesion
0-2	0.25	Very Soft
3-4	0.25-0.5	Soft
5-8	0.5-1	Medium Stiff
9-16	1-2	Stiff
17-32	2-4	Very Stiff
above 32	above 4	Hard

Grading: When Soil characteristics vary gradually with depth within the same soil stratum, the variation is described by using the term "grading".

N.P.M.: Natural Percent Moisture of in situ soil sample.

N.D.: Natural Density of in situ soil sample in p.c.f.

S.S.: Shear Stength of cohesive soil samples as determined by the Unconfined Compression Tests in K.S.F.

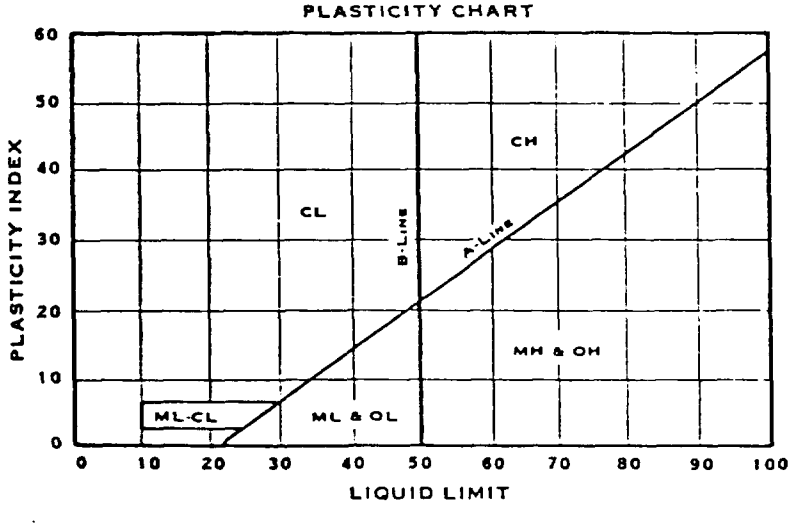
Classification Data: Laboratory data to assist in classification of soils and classification of soil characteristics. ie: Plastic Limit, Liquid Limit.

MATERIALS TESTING CONSULTANTS INC.

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
			GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMT. OF FINES)	GM	SILTY GRAVELS, GRAVEL-SANDY-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SAND (LITTLE OR NO FINES)	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
			SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMT. OF FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS & VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
	HIGHLY ORGANIC SOILS		PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

FOR LABORATORY CLASSIFICATION OF FINE GRAINED SOILS



SUMMARY OF LABORATORY TEST DATA

Boring Number	Sample Depth	Sample Type**	Sample Description and USCS Classification	Unit Weight pcf		Unconfined Compressive Strength KSF	Percent Finer No. 200 Sieve	Specific Gravity	Natural Moisture Content	Atterberg Limits			MTCI Sample Number	
				Wet	Dry					L.L.	P.L.	P.I.		
1A	2-4'	SS 2	gray silty clay (CL)						11.4	20.9	13.5	7.4	92921	
1A	4-6'	SS 3	gray clay with f-c sand and f gravel (CL)				58.8	2.68					92899	*
1A	14-16'	SS 8	gray silty clay (CL-ML)						9.4	16.9	11.4	5.5	92922	
1A	18-20'	SS 10	gray silty clay (CL-ML)						5.3	15.0	10.8	4.2	92923	
1A	28-30'	SS 12	brown & gray mottled silty clay (CL-ML)						7.0	18.0	12.5	5.5	92924	
1A	34½-36'	SS 13	gray clay with f to c sand and f gravel (CL)				56.6	2.68					92900	*
1C	23½-25'	SS 1	gray fine to c sand with some f gravel (SW)				6.0						92901	*
1C	29½-31'	SS 2	gray fine sand with some silt (SM)				34.6	2.670					92902	*
1C	34½-36'	SS 3	gray silty clay with f-c sand & f gravel(CL-ML)						5.7	22.6	18.3	4.3	92925	
1C	39½-41'	SS 4	gray clay with f-c sand & f gravel (CL)				65.5	2.70					92903	*

* Graphic Presentations of Results of Triaxial, Consolidation, CBR, Proctor, Grain Size, and other tests follow this summary

** SS = Solit Spoon Sample (ASTM D 1586)
UD = Undisturbed Sample (ASTM D 1587)

Materials Testing Consultants, Inc.
693 PLYMOUTH N.E., GRAND RAPIDS, MICH. 49505 • PHONE 616/458-9469

JOB NUMBER: 162G

SUMMARY OF LABORATORY TEST DATA

Boring Number	Sample Depth	Sample Type**	Sample Description and USCS Classification	Unit Weight pcf		Unconfined Compressive Strength KSF	Percent Finer No. 200 Sieve	Specific Gravity	Natural Moisture Content	Atterberg Limits			MTCI Sample Number	
				Wet	Dry					L.L.	P.L.	P.I.		
1C	54½-56'	SS 7	brown & gray mottled clay (CL)						10.5	40.8	21.9	18.9	92926	
1C	64½-65½'	SS 10	gray silty clay with some f-c sand (CL)						5.9	16.2	11.8	4.4	92927	
1C	74½-76'	SS 12	brown silt with f-c sand & f gravel (ML)				58.3	2.68					92904	*
1C	79½-80½'	SS 13	brown silt with f-c sand and f gravel (ML)						6.0	15.6	11.9	3.7	92928	
1C	139½-141'	SS 25	blue gray silty clay (CL)						15.2	47.5	19.4	28.1	92929	
1C	154½-156'	SS 28	gray silty f-c sand with some f gravel (SM-SW)				11.5						92905	*
2C	4-6'	SS 3	gray silty clay with some fine gravel (CL-ML)						7.5	17.7	11.3	6.4	92930	
2C	12-14'	SS 7	gray silty clay (CL-ML)						7.8	16.3	10.9	5.4	92931	
2C	16-18'	SS 9	gray f-c sand (SP)				5.8						92906	*
2C	20-22'	SS 11	gray f-c sand with some fine gravel (SW)				4.9						92907	*

* Graphic Presentations of Results of Triaxial, Consolidation, CBR, Proctor, Grain Size, and other tests follow this summary

** SS = Split Spoon Sample (ASTM D 1586)
UD = Undisturbed Sample (ASTM D 1587)

Materials Testing Consultants, Inc.
693 PLYMOUTH N.E., GRAND RAPIDS, MICH. 49505 • PHONE 616/456-8469

JOB NUMBER: 162G

SUMMARY OF LABORATORY TEST DATA

Boring Number	Sample Depth	Sample Type**	Sample Description and USCS Classification	Unit Weight pcf		Unconfined Compressive Strength KSF	Percent Finer No. 200 Sieve	Specific Gravity	Natural Moisture Content	Atterberg Limits			MTCI Sample Number	
				Wet	Dry					L.L.	P.L.	P.I.		
2C	26-28'	SS 14	gray f-c sand with some f gravel (SW)				2.3						92965	*
2C	32-34'	SS 17	gray f-c sand with some silt (SM)				33.9						92908	*
2C	44½-46'	SS 20	gray clay with some f-c sand (CL)						2.9	23.9	12.5	11.4	92932	
2C	49½-51'	SS 21	gray clay with some f-c sand (CL)				67.6	2.699					92909	*
2C	79½-80½'	SS 27	gray clayey silt (CL-ML)						8.0	19.5	13.1	6.4	92933	
2C	99½-100½'	SS 31	brown f-c sand with little gravel (SP-SM)				10.0						92910	*
2C	119½-121'	SS 35	gray silty clay (CL)						10.5	22.2	14.7	7.5	92934	
2C	144½-146'	SS 40	gray clay with some f-c sand (ML-CL)						15.8	21.1	14.3	6.8	92935	
2C	149½-151'	SS 41	gray f-m sand with limestone (SM) chips & little silt				13.9						92911	*
3A	2-4'	SS 2	brown clay fill (CL)						12.7	26.4	16.5	9.9	92936	

* Graphic Presentations of Results of Triaxial, Consolidation, CBR, Proctor, Grain Size, and other tests follow this summary

** SS = Split Spoon Sample (ASTM D 1586)
UD = Undisturbed Sample (ASTM D 1587)

SUMMARY OF LABORATORY TEST DATA

Boring Number	Sample Depth	Sample Type**	Sample Description and USCS Classification	Unit Weight pcf		Unconfined Compressive Strength KSF	Percent Finer No. 200 Sieve	Specific Gravity	Natural Moisture Content	Atterberg Limits			MTCI Sample Number	
				Wet	Dry					L.L.	P.L.	P.I.		
3A	8-10'	SS 5	brown f-c sand with little silt (SM-SW)				11.1						92912	*
3A	14-16'	SS 8	brown f-c sand with little f-c gravel & silt (SM)				15.4						92913	*
3A	18-20'	SS 10	gray silty clay with little f-c sand (CL-ML)						9.9	17.6	13.1	4.5	92937	
3C	34½-36'	SS 14	gray silty clay (CL-ML)						10.6	21.1	14.2	6.9	92938	
3C	64½-66'	SS 20	gray silty clay with some f-c sand & f gravel (CL-ML)						7.3	19.8	14.3	5.5	92939	
3C	104½-106'	SS 28	gray clayey silt with trace sand (ML)						8.7	17.0	13.6	3.4	92940	
3C	129½-131'	SS 33	brown silty clay (CL)						13.7	35.1	19.9	17.2	92941	
3C	139½-141'	SS 35	gray f-m sand with little silt (SM)				12.9						92914	*
4C	6-8'	SS 4	gray clayey silt with little f-c sand (ML)						11.4	16.5	12.6	3.9	93000	
4C	8-10'	SS 5	gray f-c sand with clay (SC)				47.8	2.702	10.1				93001	*

* Graphic Presentations of Results of Triaxial, Consolidation, CBR, Proctor, Grain Size, and other tests follow this summary

** SS = Split Spoon Sample (ASTM D 1586)
UD = Undisturbed Sample (ASTM D 1587)

Materials Testing Consultants, Inc.
693 PLYMOUTH N.E., GRAND RAPIDS, MICH. 49505 • PHONE 616/456-5468

JOB NUMBER: 162G

SUMMARY OF LABORATORY TEST DATA

Boring Number	Sample Depth	Sample Type**	Sample Description and USCS Classification	Unit Weight pcf		Unconfined Compressive Strength KSF	Percent Finer No. 200 Sieve	Specific Gravity	Natural Moisture Content	Atterberg Limits			MTCI Sample Number	
				Wet	Dry					L.L.	P.L.	P.I.		
4C	12-14'	SS 7	gray f-c sand with clay (SC)				39.4	2.728	4.8				93002	*
4C	18-19'	SS 10	gray silty clay (CL)						7.6	19.1	11.9	7.2	93003	
4C	20-22'	SS 11	gray clay with f-c sand (CL)				53.0	2.734	3.1				93004	*
4C	39½-41'	SS 16	gray clay with f-c sand (CL)						9.9	21.8	12.8	9.0	93005	
4C	54½-56'	SS 19	greenish gray clay (CL).						19.9	38.0	17.6	10.4	93006	
4C	94½-95.9'	SS 27	gray clayey silt (ML)						9.4	18.2	14.6	3.6	92942	
4C	139½-141'	SS 36	brown silty clay with f-c sand (CL)						8.2	37.6	16.1	21.5	92943	
4C	149½-150.9'	SS 38	gray fine sand with little silt (SM)				13.1						92915	*
4C	154½-155½'	SS 39	gray f-c sand with little silt (SM)				12.7						92916	*
5A	4½-6½'	SS 1	brown & gray mottled silty clay w/tr gravel	(CL-ML)					7.8	19.4	14.2	5.2	92944	

* Graphic Presentations of Results of Triaxial, Consolidation, CBR, Proctor, Grain Size, and other tests follow this summary

** SS = Split Spoon Sample (ASTM D 1586)
UD = Undisturbed Sample (ASTM D 1587)

Materials Testing Consultants, Inc.
693 PLYMOUTH N.E., GRAND RAPIDS, MICH. 49505 • PHONE 616/456-5469

JOB NUMBER: 162G

SUMMARY OF LABORATORY TEST DATA

Boring Number	Sample Depth	Sample Type**	Sample Description and USCS Classification	Unit Weight pcf		Unconfined Compressive Strength KSF	Percent Finer No. 200 Sieve	Specific Gravity	Natural Moisture Content	Atterberg Limits			MTCI Sample Number	
				Wet	Dry					L.L.	P.L.	P.I.		
5A	9½-11½'	SS 2	gray f-c sand with silt (SM)				43.6	2.716					92917	*
5A	19½-20½'	SS 4	gray f-c sand with little f gravel (SW)				2.8						92918	*
5A	29½-31½'	SS 6	gray f-c sand with trace gravel and silt (SW)				5.9						92919	*
5A	29½-31½	SS 7	gray fine sand with some silt (SM)				26.7						92920	*

* Graphic Presentations of Results of Triaxial, Consolidation, CBR, Proctor, Grain Size, and other tests follow this summary

** SS = Split Spoon Sample (ASTM D 1586)
UD = Undisturbed Sample (ASTM D 1587)

Materials Testing Consultants, Inc.
683 PLYMOUTH N.E., GRAND RAPIDS, MICH. 49505 • PHONE 616/456-9469

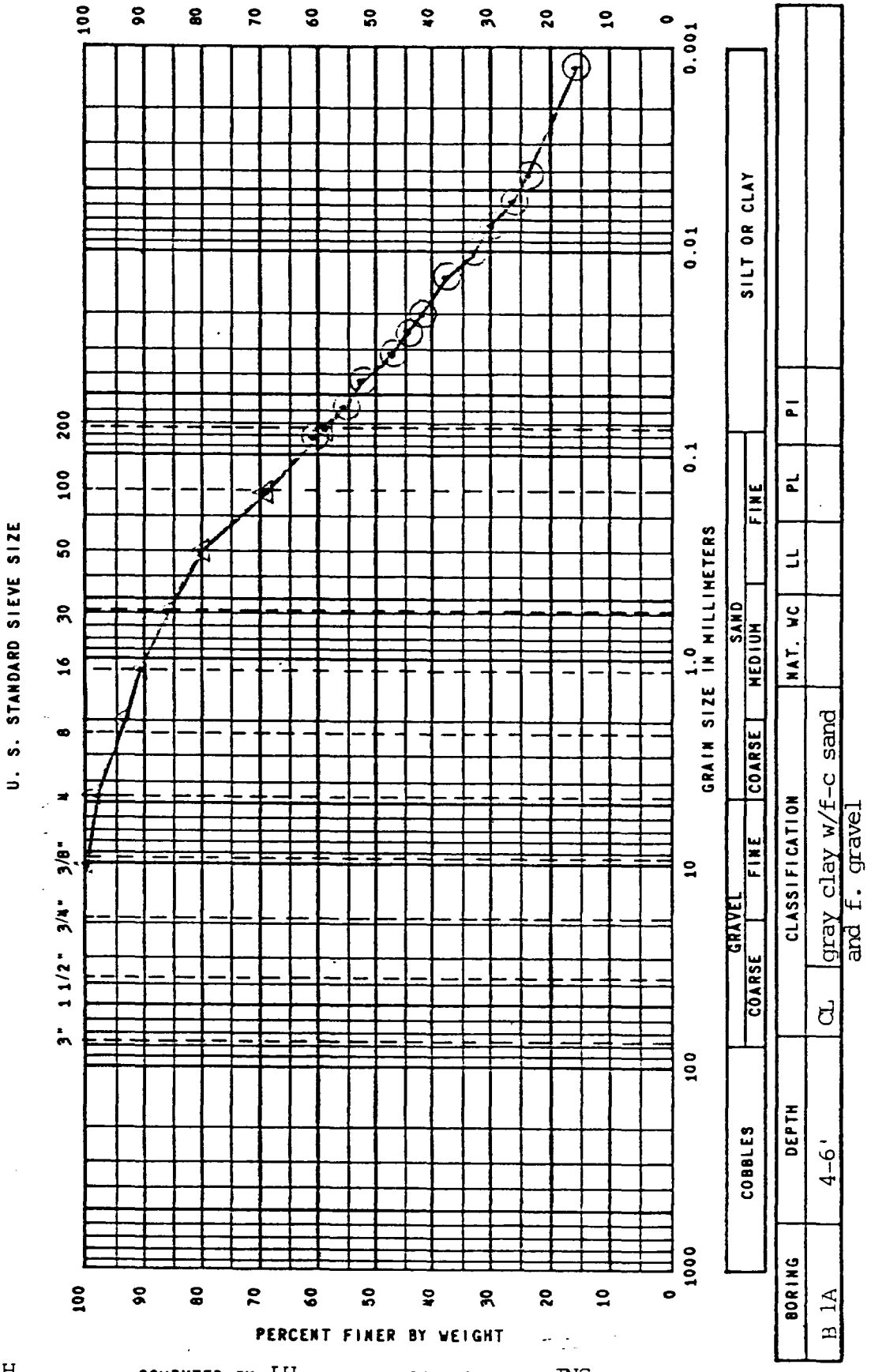
JOB NUMBER: 162G

GRADATION CURVE

DATE 7/25/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 1A SAMPLE NUMBER 92899



BORING	DEPTH	CLASSIFICATION	NAT. WC	LL	PL	PI
B 1A	4-6'	CL gray clay w/f-c sand and f. gravel				

TECHNICIAN LH COMPUTED BY LH CHECKED BY JNS

REMARKS

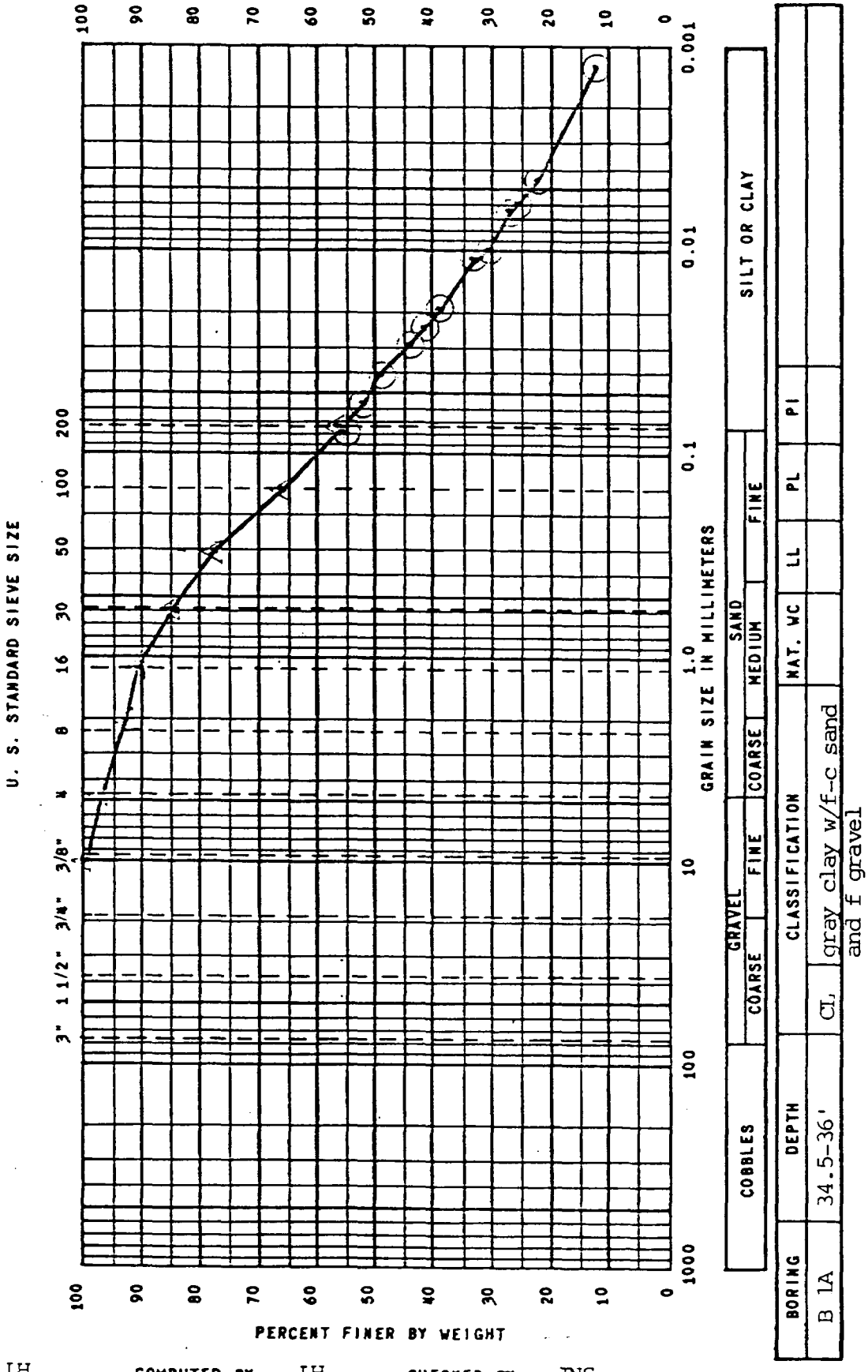
Materials Testing Consultants

GRADATION CURVE

DATE 7/25/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 1A SAMPLE NUMBER 92900



TECHNICIAN LH COMPUTED BY LH CHECKED BY JNS

REMARKS

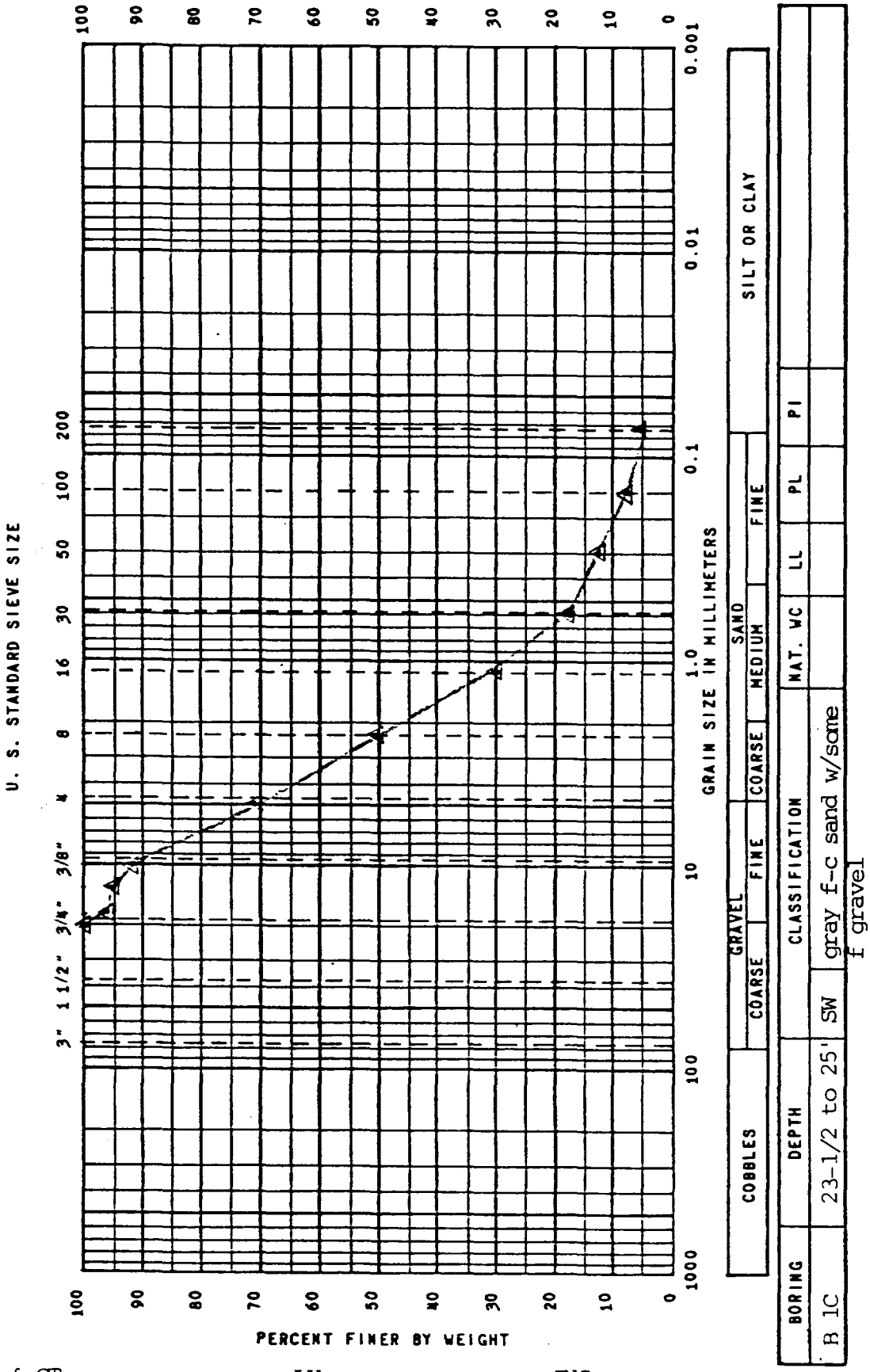
Materials Testing Consultants

GRADATION CURVE

DATE 7/11/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 1C SAMPLE NUMBER 92901



TECHNICIAN LH & GT COMPUTED BY LH CHECKED BY JNS

REMARKS

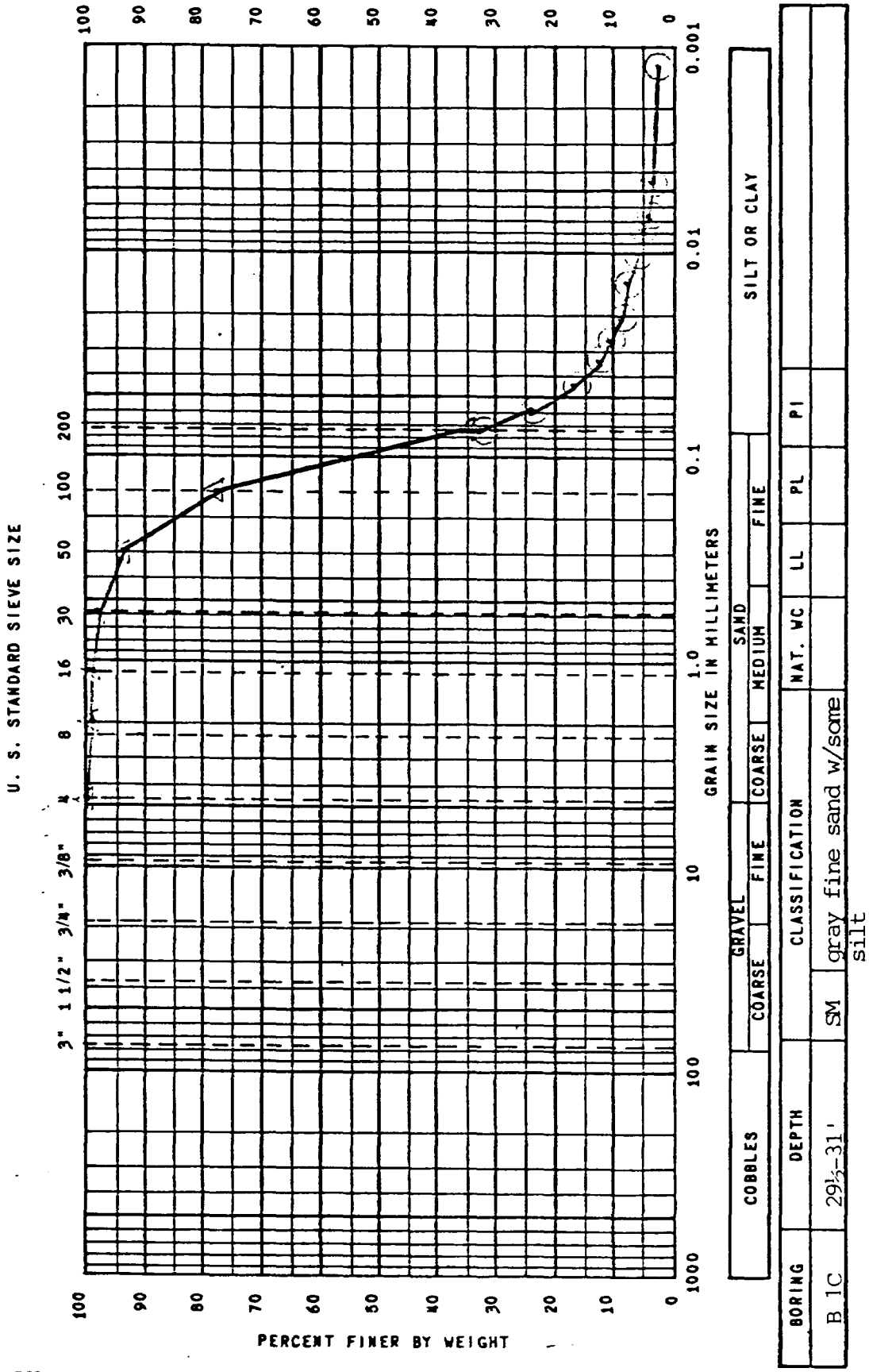
Materials Testing Consultants

GRADATION CURVE

DATE 7/25/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 1C SAMPLE NUMBER 92902



TECHNICIAN LH COMPUTED BY LH CHECKED BY JNS

REMARKS

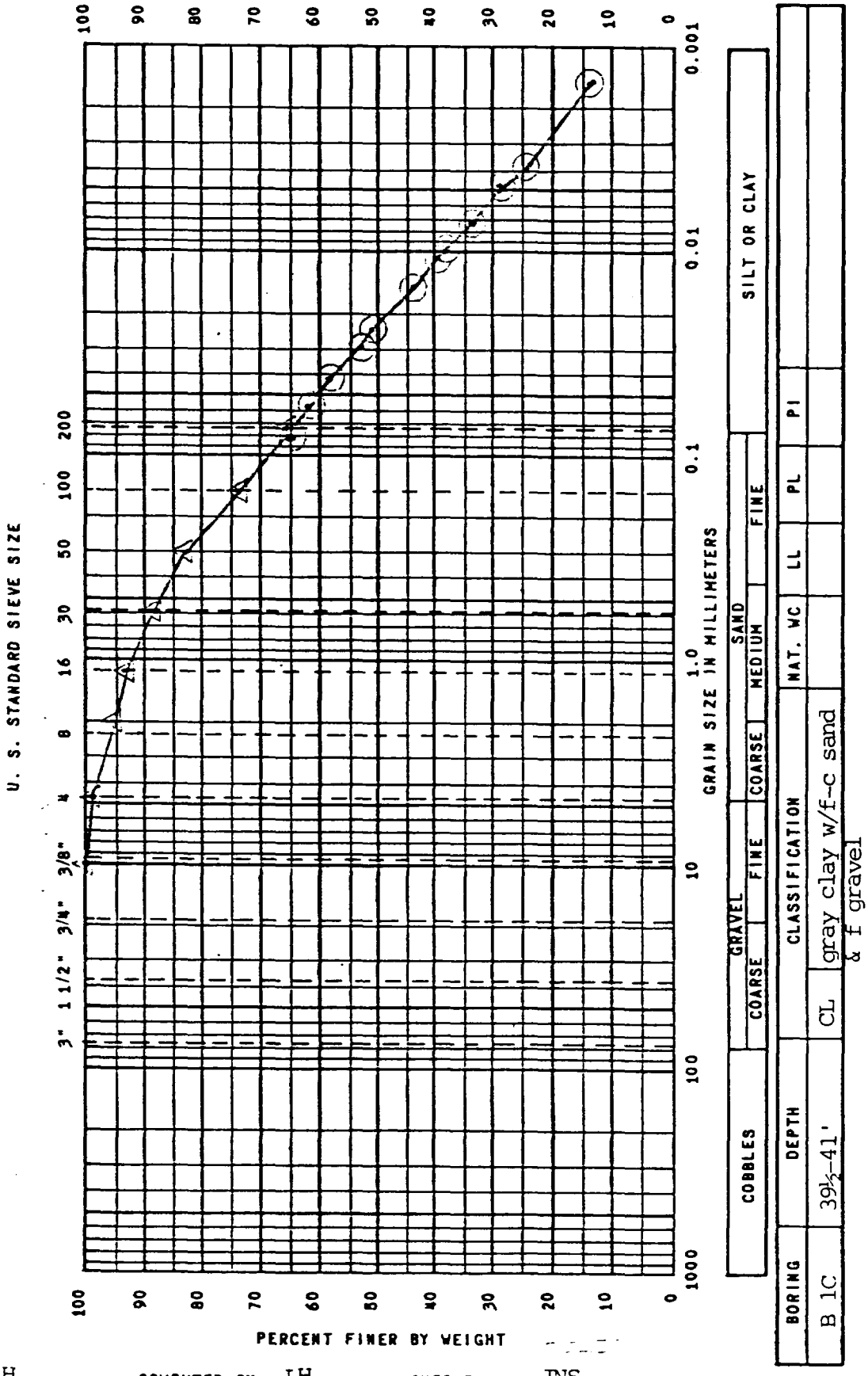
Materials Testing Consultants

GRADATION CURVE

DATE 7/25/83

CLIENT CH2M HILL PROJECT Zionsville, Michigan

JOB NUMBER 162G BORING NUMBER B 1C SAMPLE NUMBER 92903



TECHNICIAN LH COMPUTED BY LH CHECKED BY JNS

REMARKS

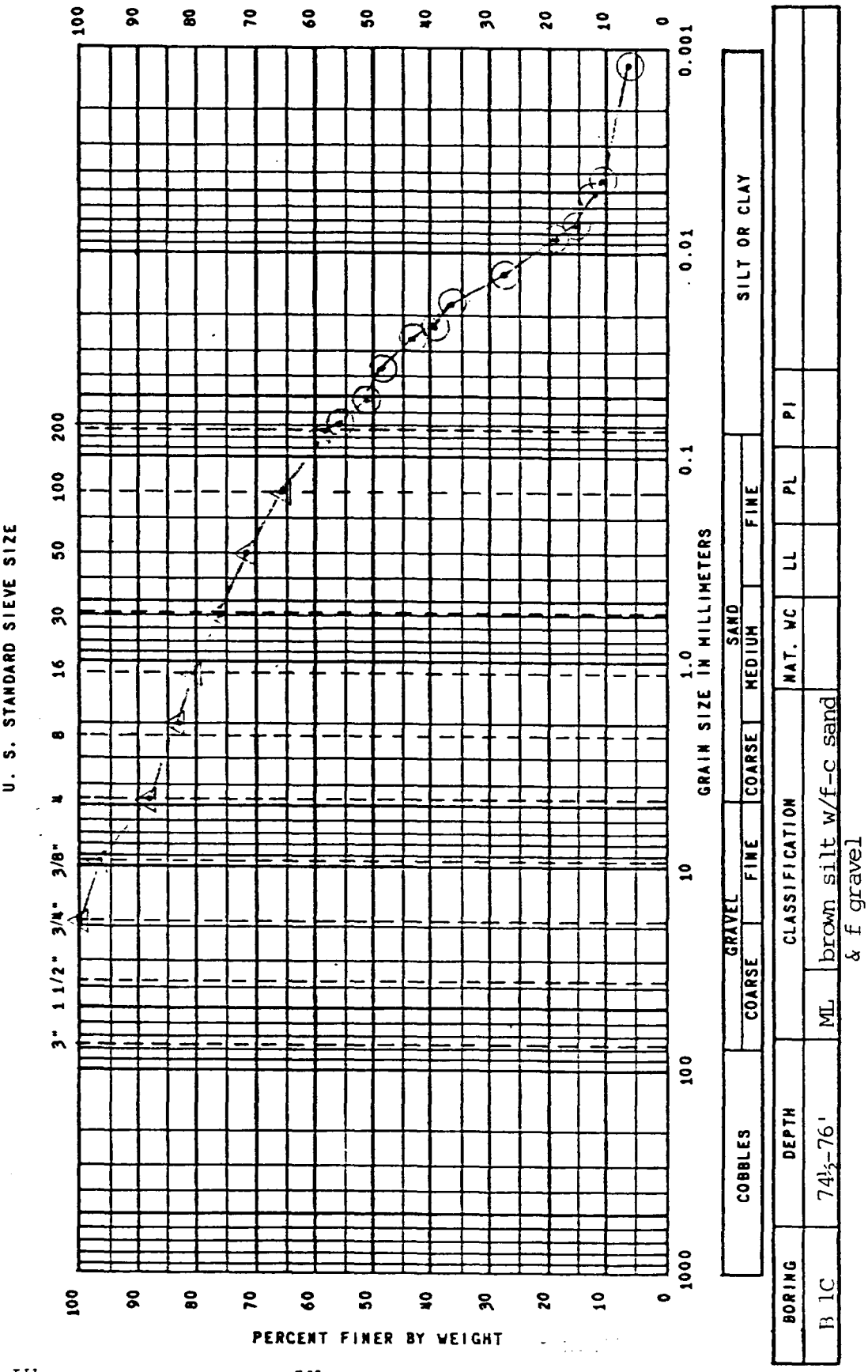
Materials Testing Consultants

GRADATION CURVE

DATE 7/25/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 1C SAMPLE NUMBER 92904



TECHNICIAN LH COMPUTED BY LH CHECKED BY JNS

REMARKS

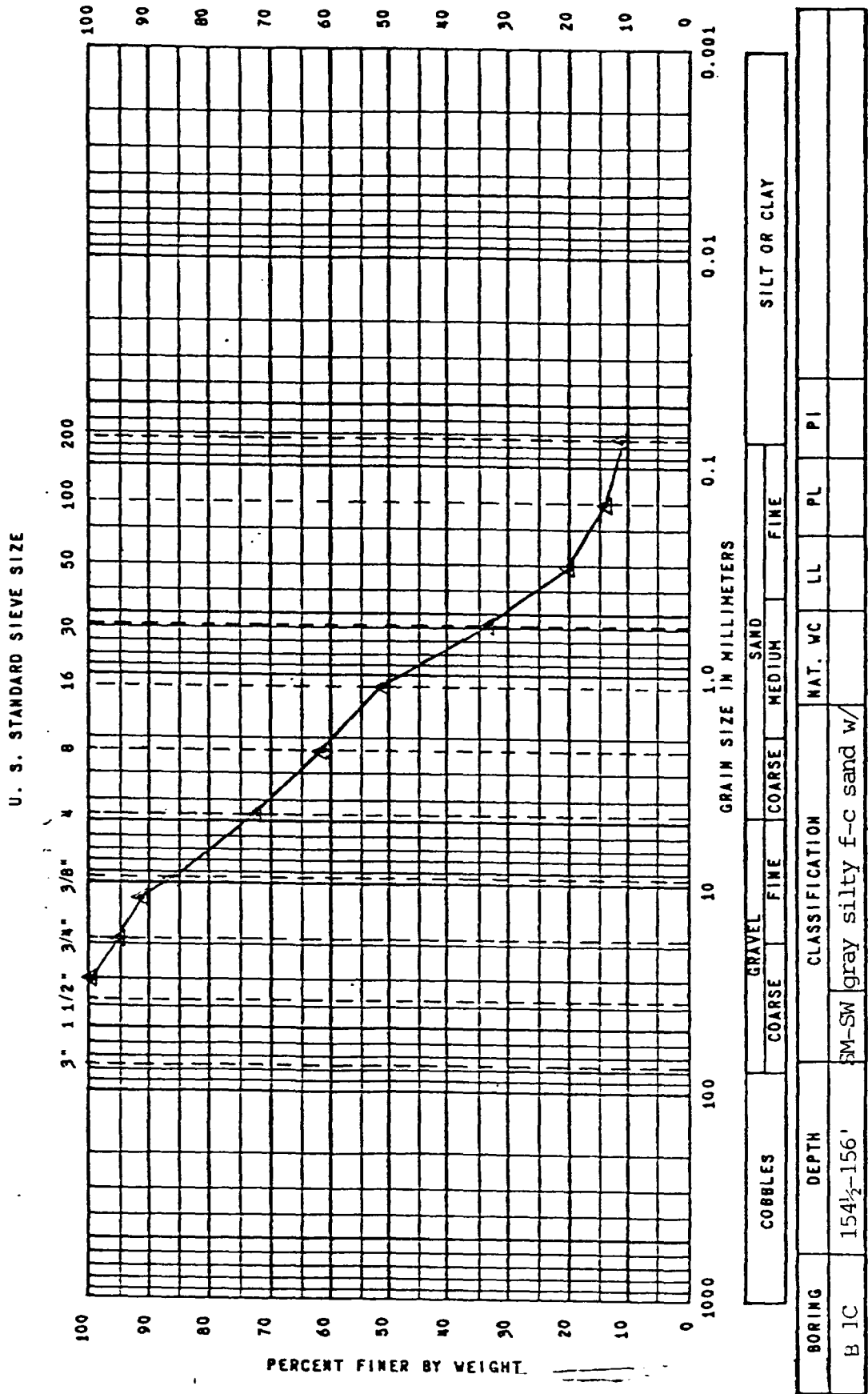
Materials Testing Consultants

GRADATION CURVE

DATE 7/8/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 1C SAMPLE NUMBER 92905



TECHNICIAN LH COMPUTED BY LH CHECKED BY JNS

REMARKS

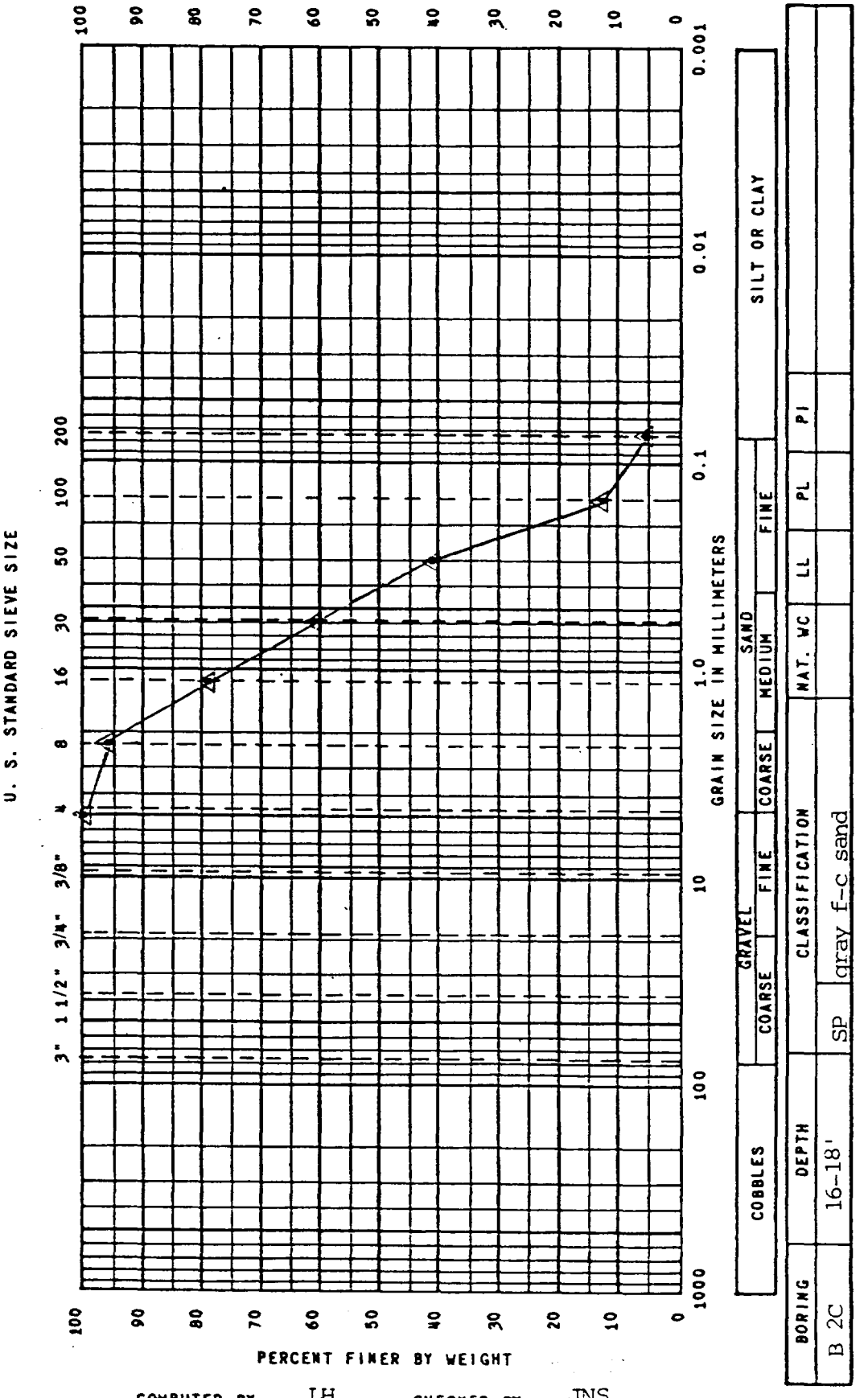
Materials Testing Consultants

GRADATION CURVE

DATE 7/8/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 2C SAMPLE NUMBER 92906



TECHNICIAN LH COMPUTED BY LH CHECKED BY JNS

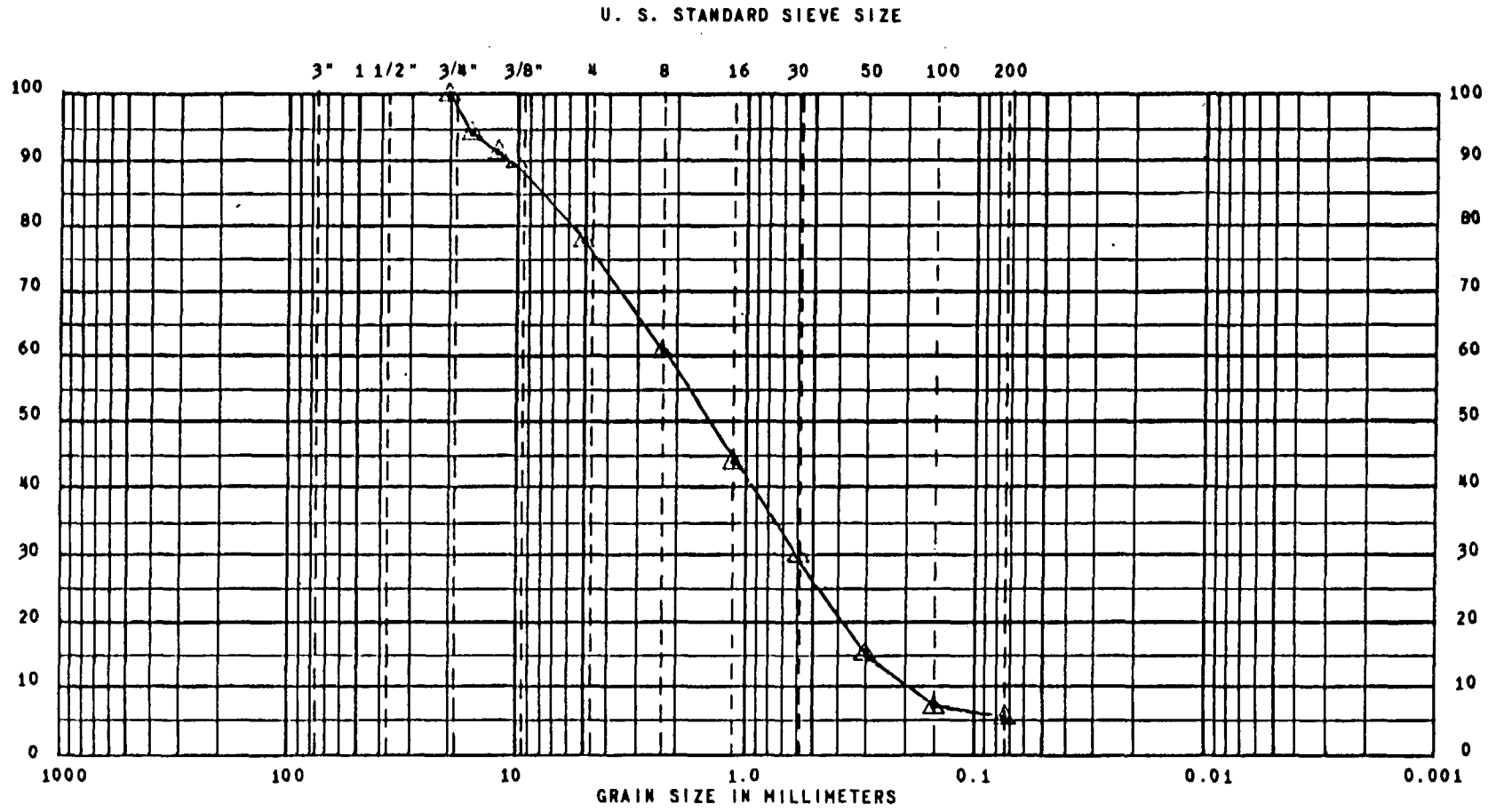
REMARKS

Materials Testing Consultants

GRADATION CURVE

CLIENT CH2M HILL PROJECT Zionsville, Indiana DATE 7/11/83

JOB NUMBER 162G BORING NUMBER B 2C SAMPLE NUMBER 92907



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

BORING	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	
B 2C	20-22'	Sw	gray f-c sand w/some fine gravel					

TECHNICIAN LH & GT COMPUTED BY LH CHECKED BY JNS

REMARKS

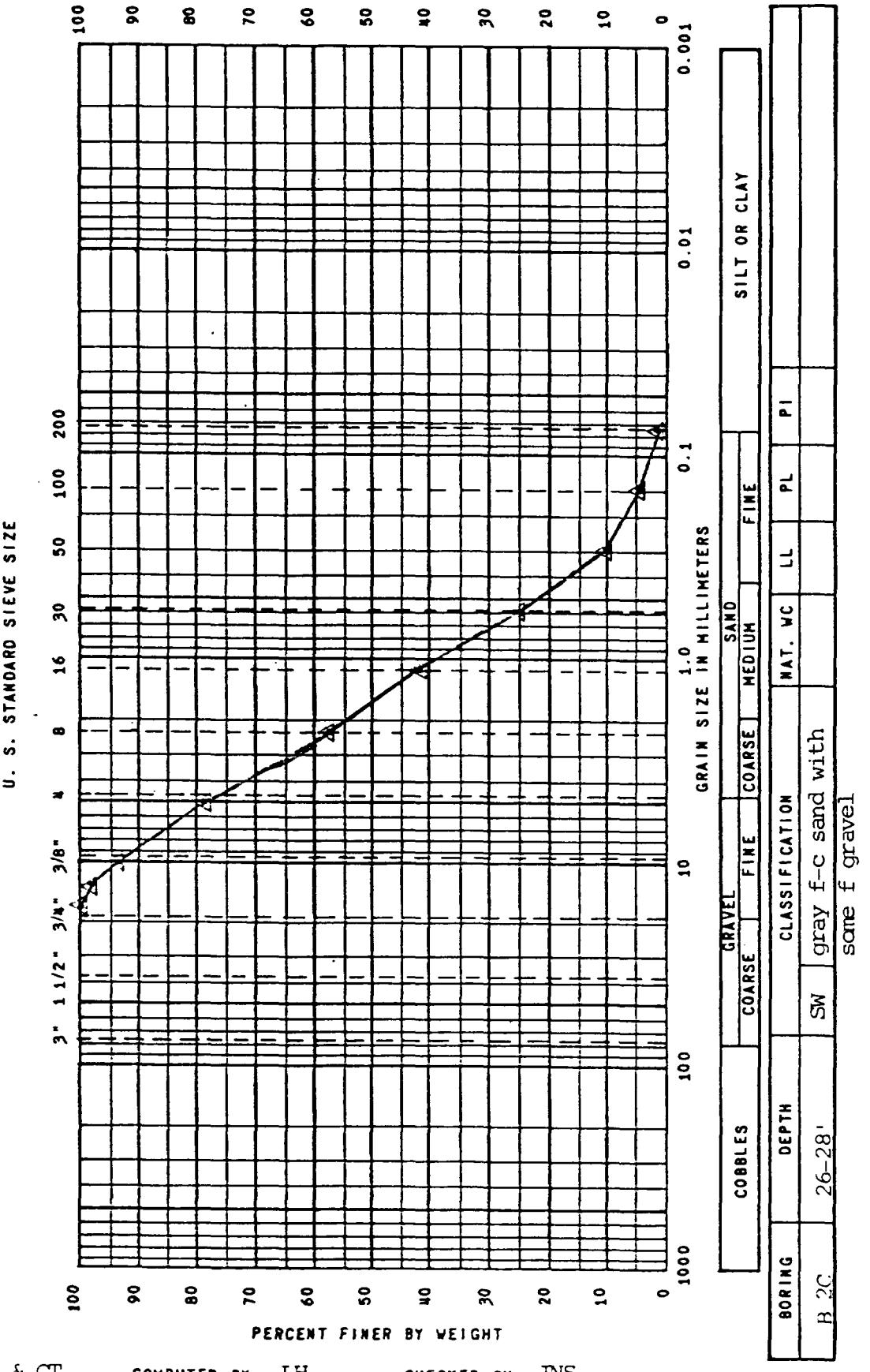
Materials Testing Consultants

GRADATION CURVE

DATE 7/11/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 2C SAMPLE NUMBER 92965



TECHNICIAN LH & GT COMPUTED BY LH CHECKED BY JNS

REMARKS

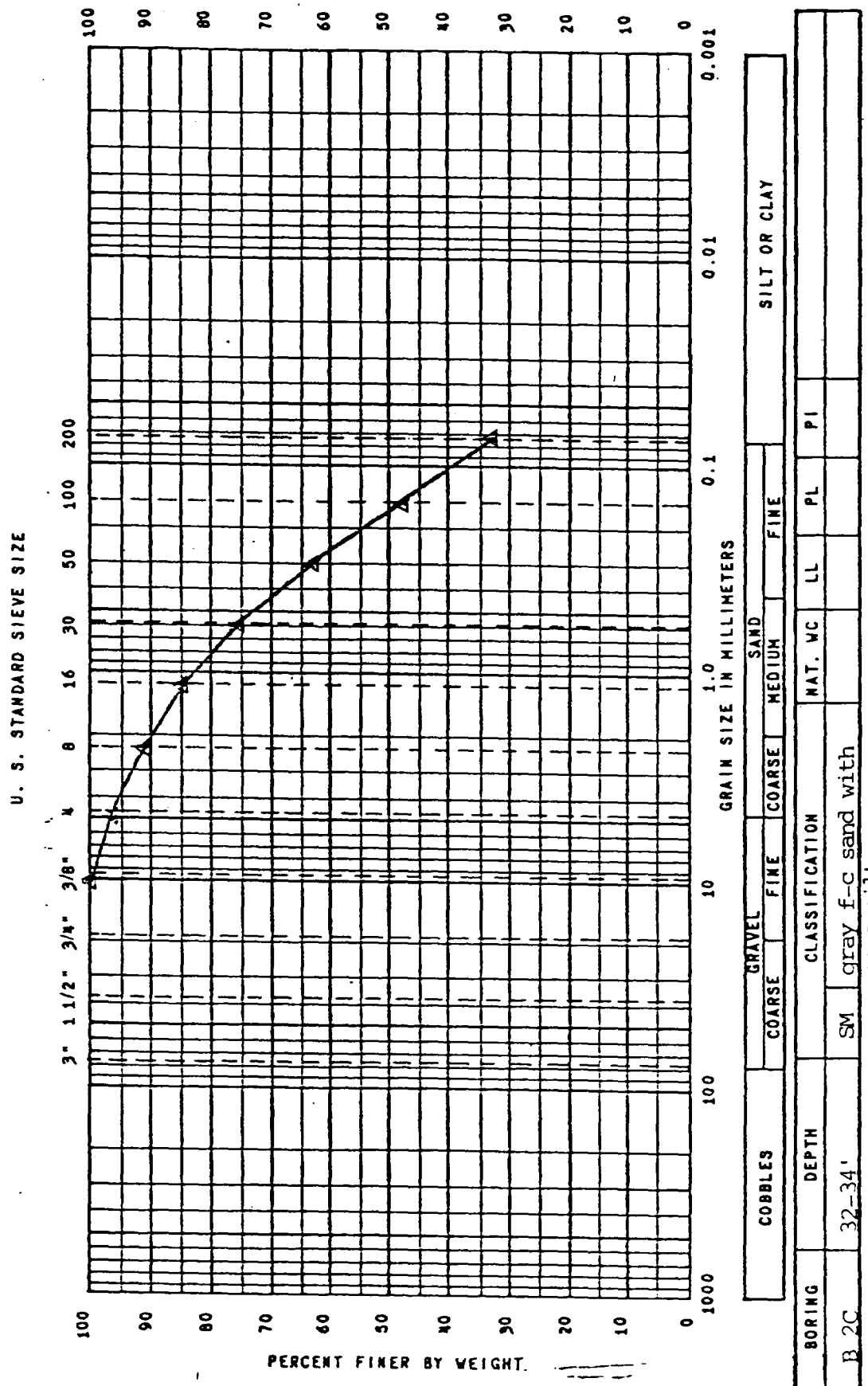
Materials Testing Consultants

GRADATION CURVE

DATE 7/5/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 2C SAMPLE NUMBER 92908



TECHNICIAN LH COMPUTED BY LH CHECKED BY JNS

REMARKS

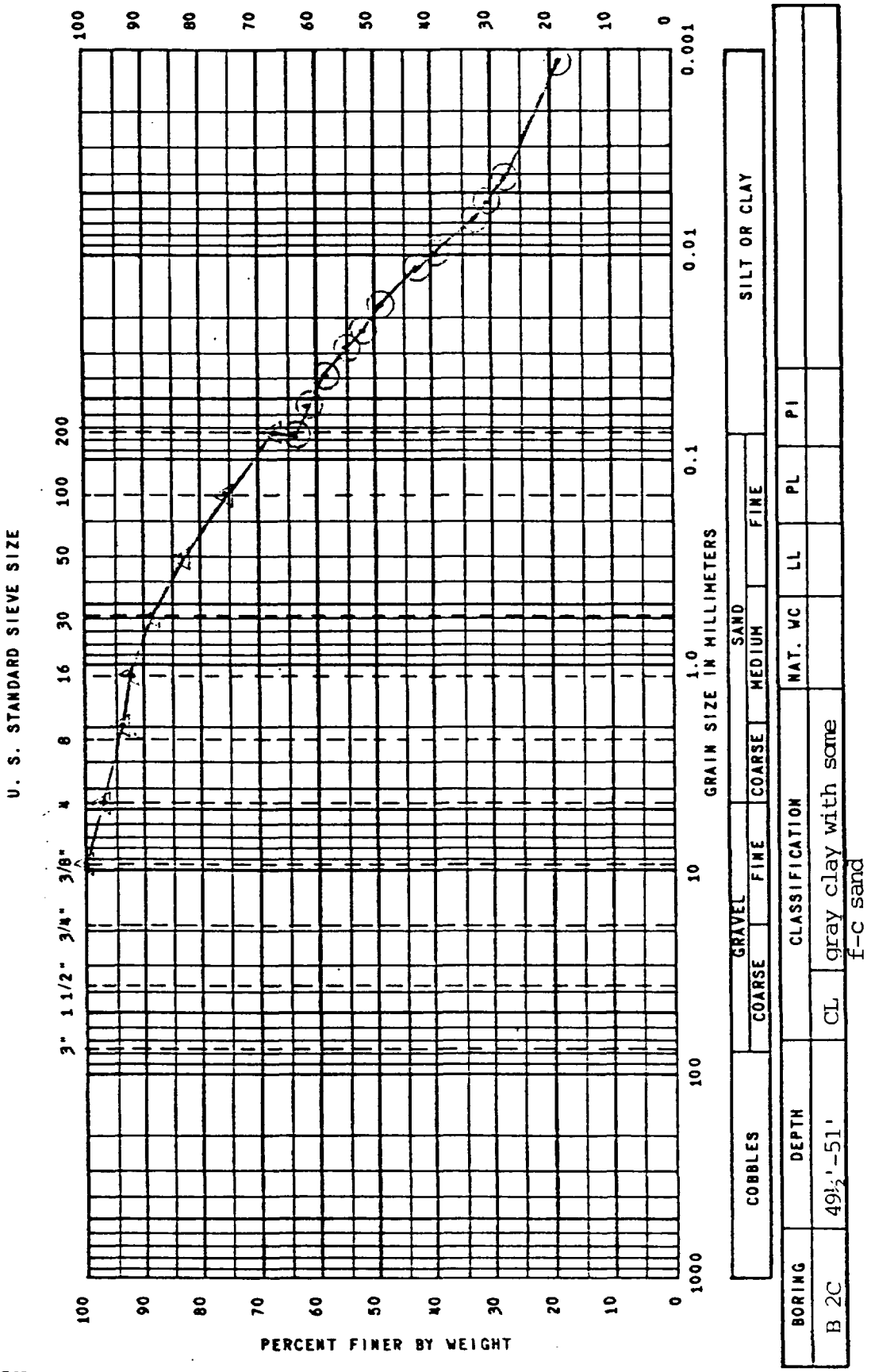
Materials Testing Consultants

GRADATION CURVE

DATE 7/25/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 2C SAMPLE NUMBER 92909



BORING	DEPTH	CLASSIFICATION	NAT. WC	LL	PL	PI
B 2C	49½'-51'	CL gray clay with some f-c sand				

TECHNICIAN LH COMPUTED BY LH CHECKED BY JNS

REMARKS

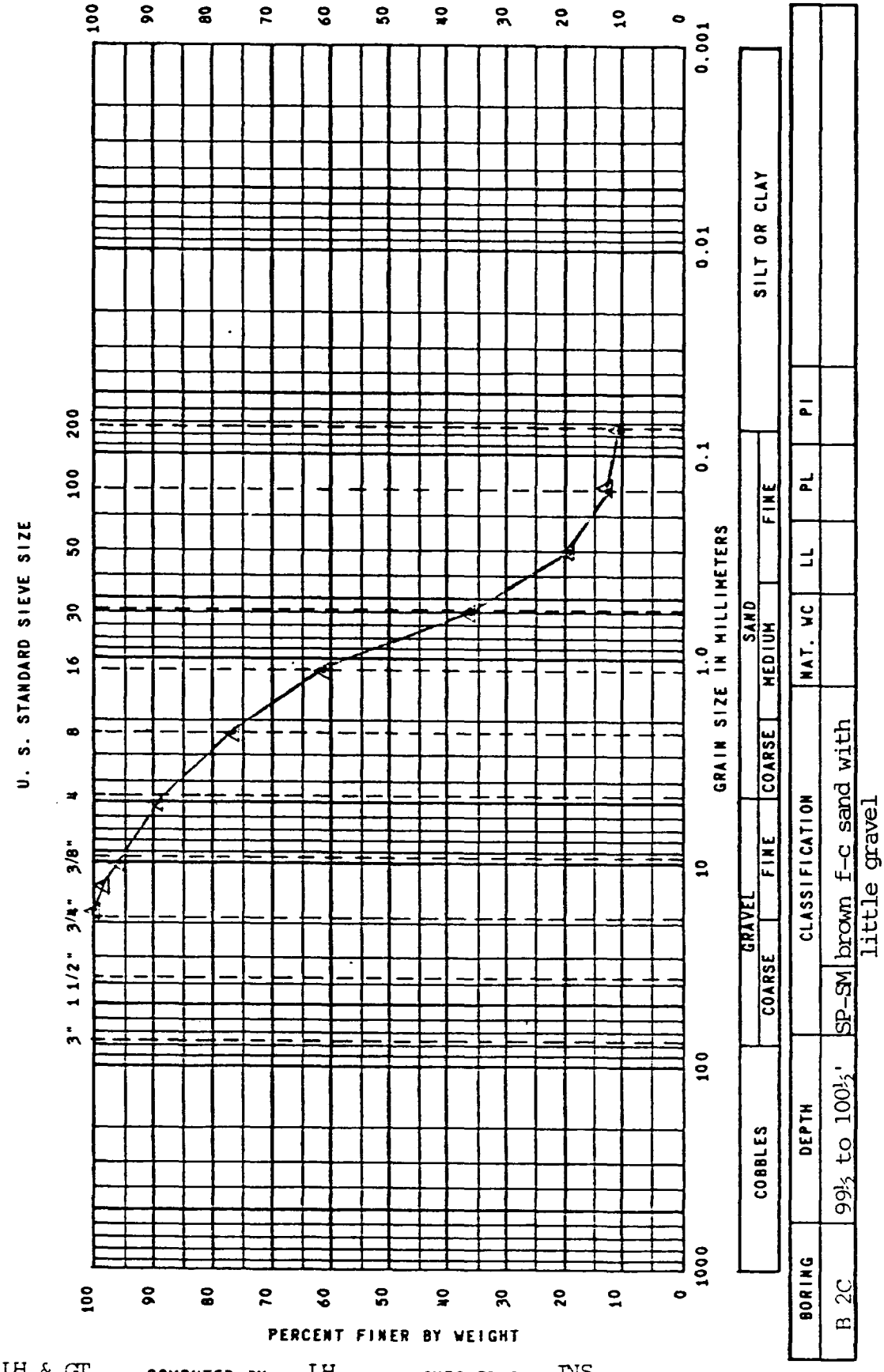
Materials Testing Consultants

GRADATION CURVE

DATE 7/11/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 2C SAMPLE NUMBER 92910



BORING	DEPTH	CLASSIFICATION	NAT. WC	LL	PL	PI
B 2C	99½ to 100½'	SP-SM brown f-c sand with little gravel				

TECHNICIAN LH & GT COMPUTED BY LH CHECKED BY JNS

REMARKS

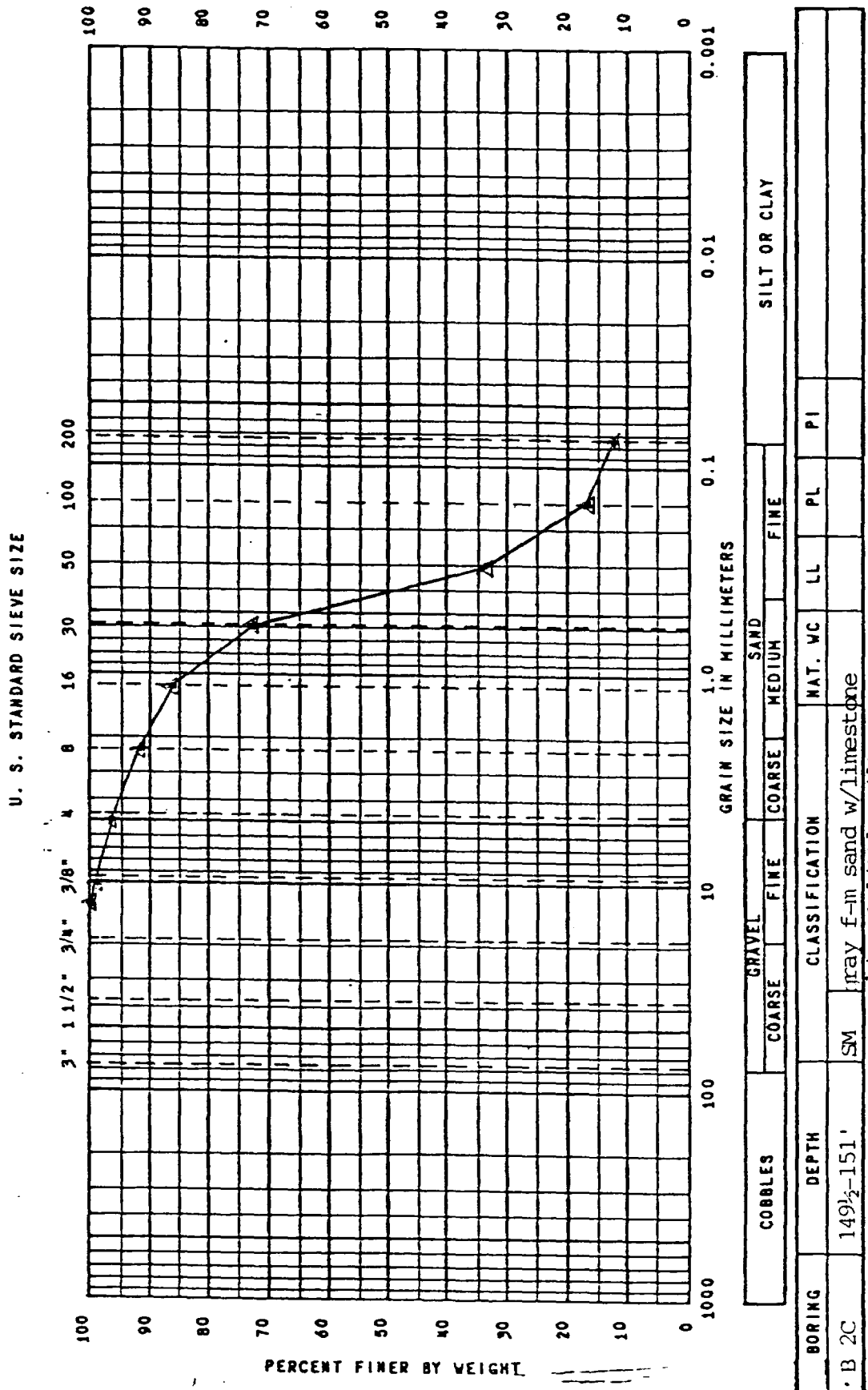
Materials Testing Consultants

GRADATION CURVE

DATE 7/5/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 2C SAMPLE NUMBER 92911



TECHNICIAN LH COMPUTED BY LH CHECKED BY JNS

REMARKS

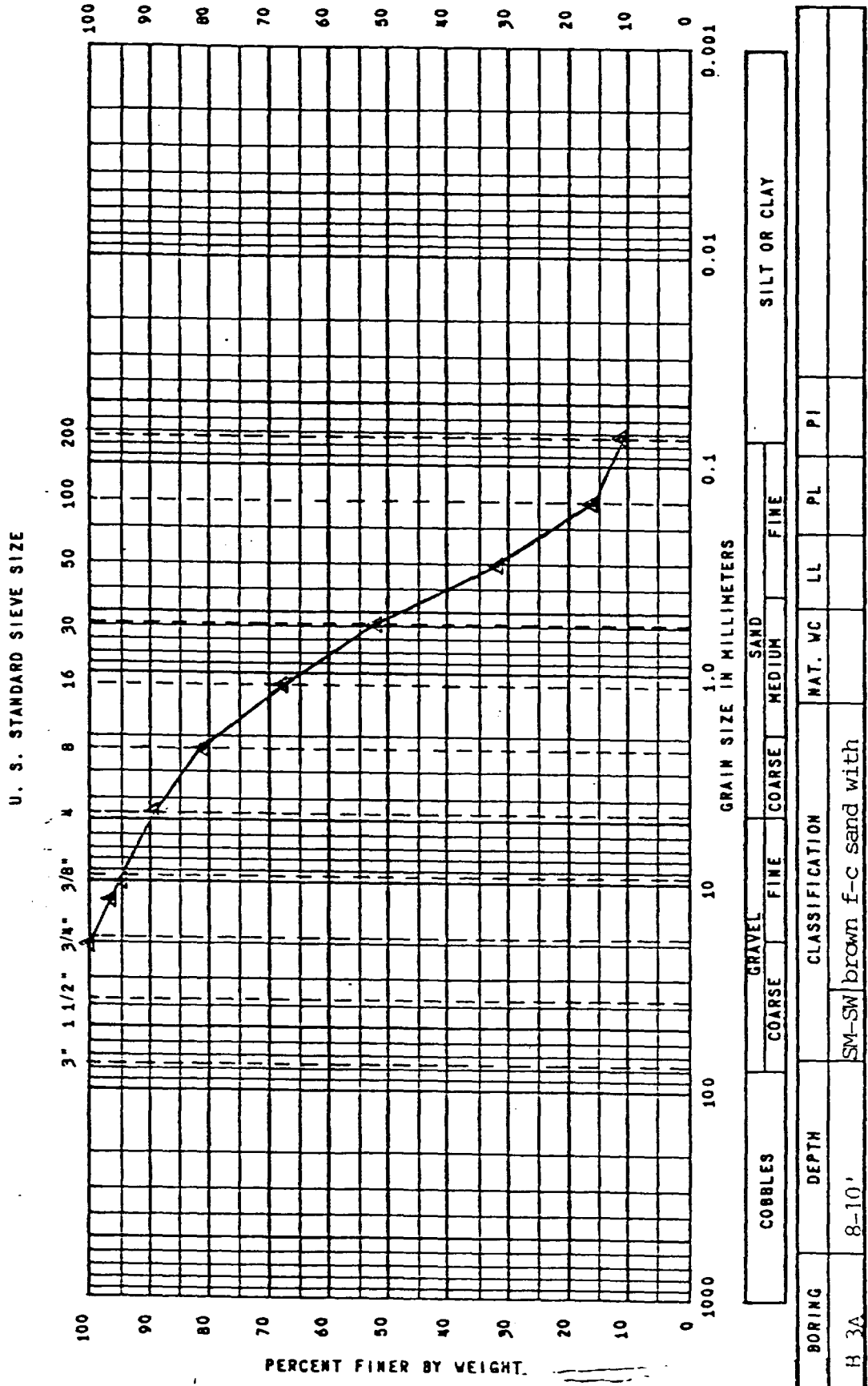
Materials Testing Consultants

GRADATION CURVE

DATE 7/7/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 3A SAMPLE NUMBER 92912



TECHNICIAN LH COMPUTED BY LH CHECKED BY JNS

REMARKS

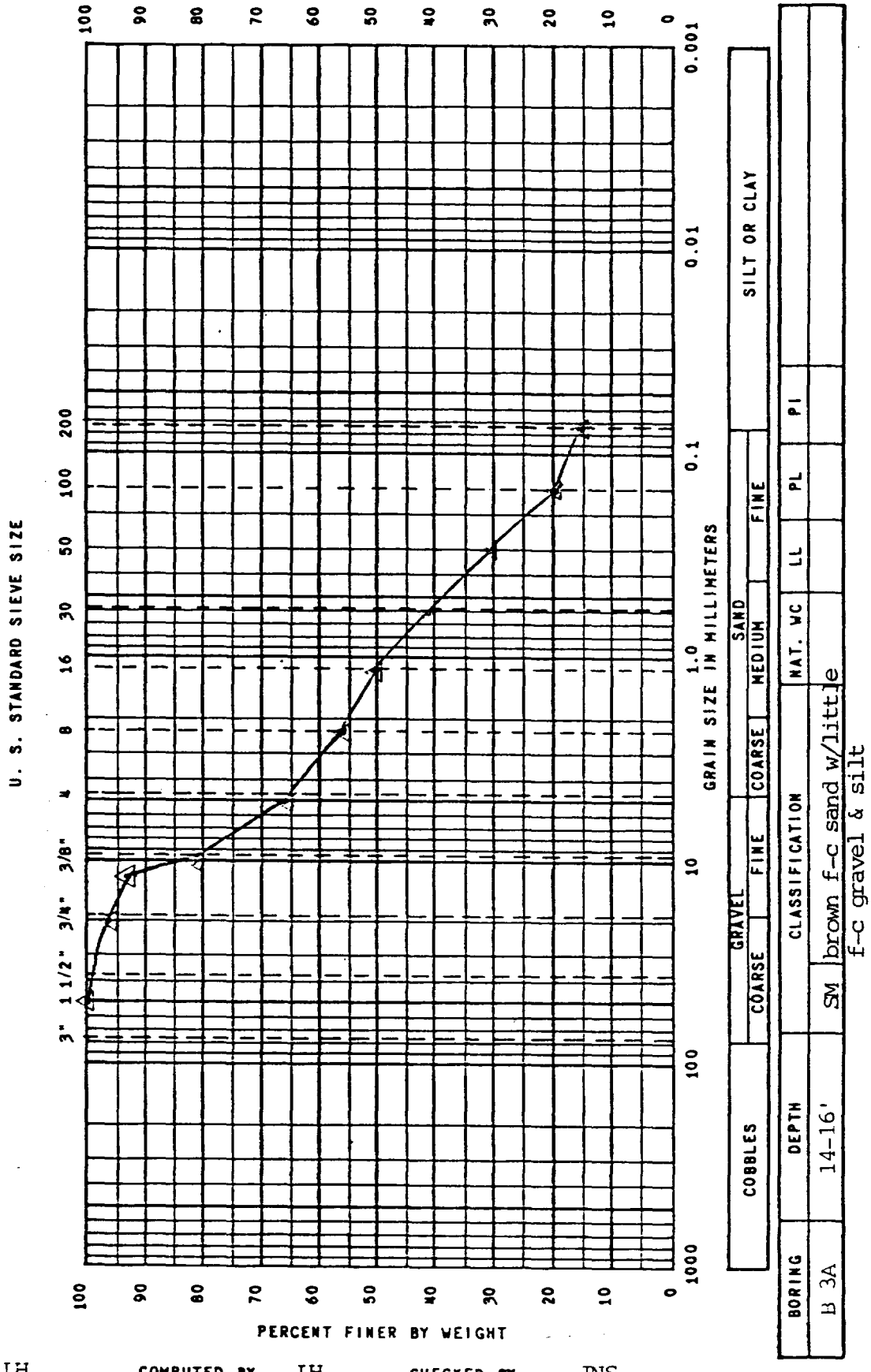
Materials Testing Consultants

GRADATION CURVE

DATE 7/8/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 3A SAMPLE NUMBER 92913



TECHNICIAN LH COMPUTED BY LH CHECKED BY JNS

REMARKS

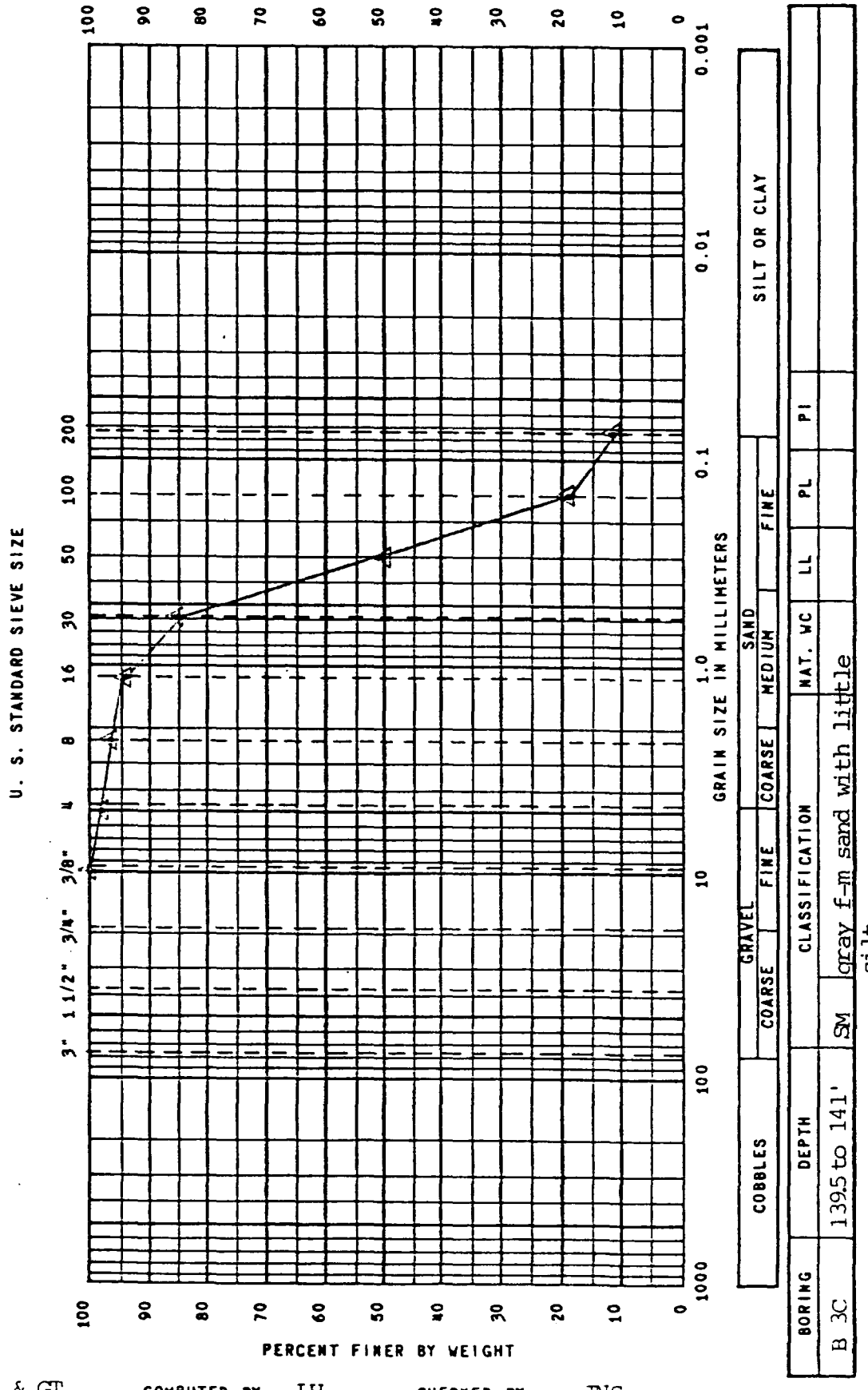
Materials Testing Consultants

GRADATION CURVE

DATE 7/7/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 3C SAMPLE NUMBER 92914



TECHNICIAN LH & GT COMPUTED BY LH CHECKED BY JNS

REMARKS

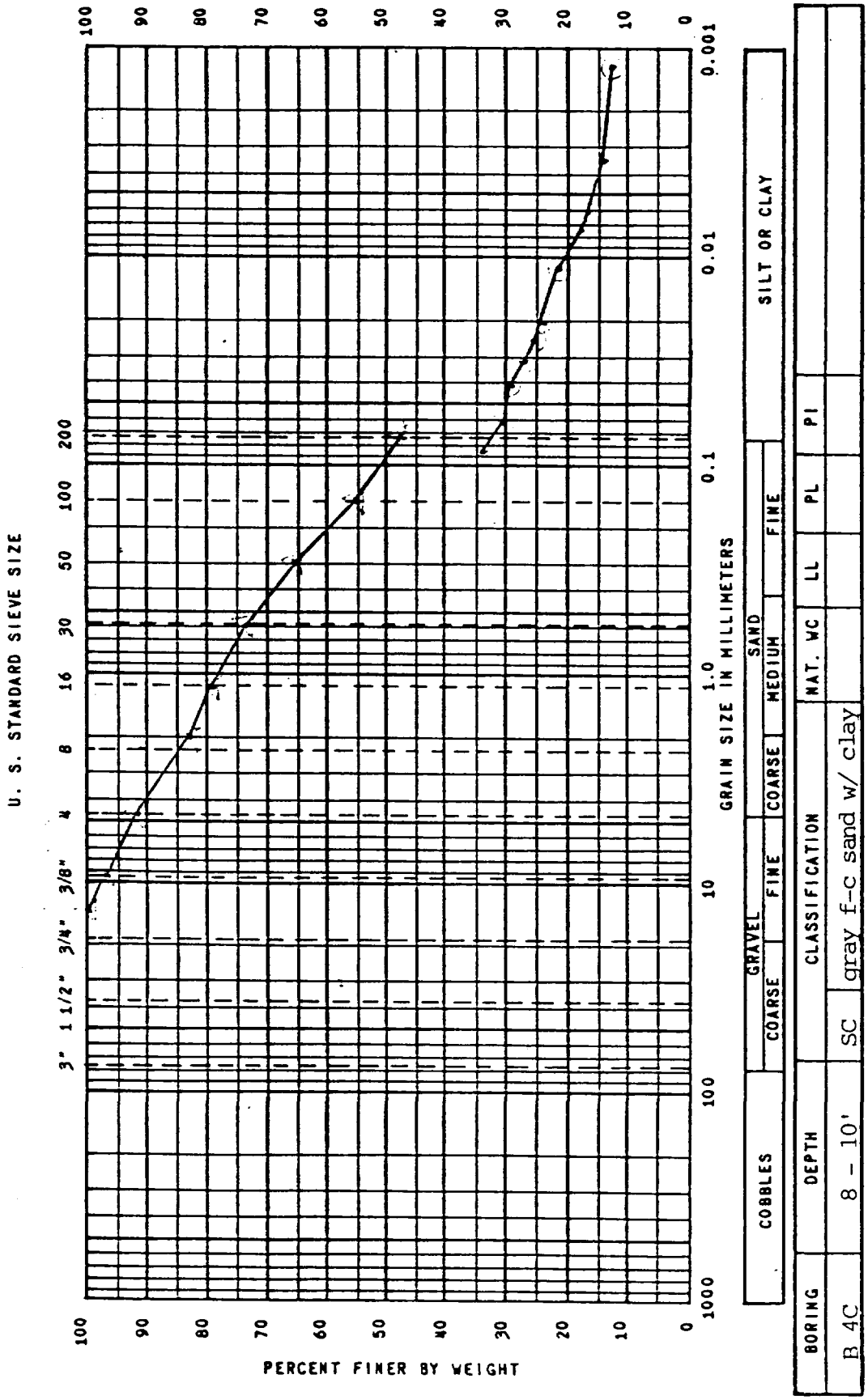
Materials Testing Consultants

GRADATION CURVE

DATE 7/13/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 4C SAMPLE NUMBER 93001



BORING	DEPTH	CLASSIFICATION	NAT. WC	LL	PL	PI
B 4C	8 – 10'	SC gray f-c sand w/ clay				

TECHNICIAN LH COMPUTED BY LH CHECKED BY JNS

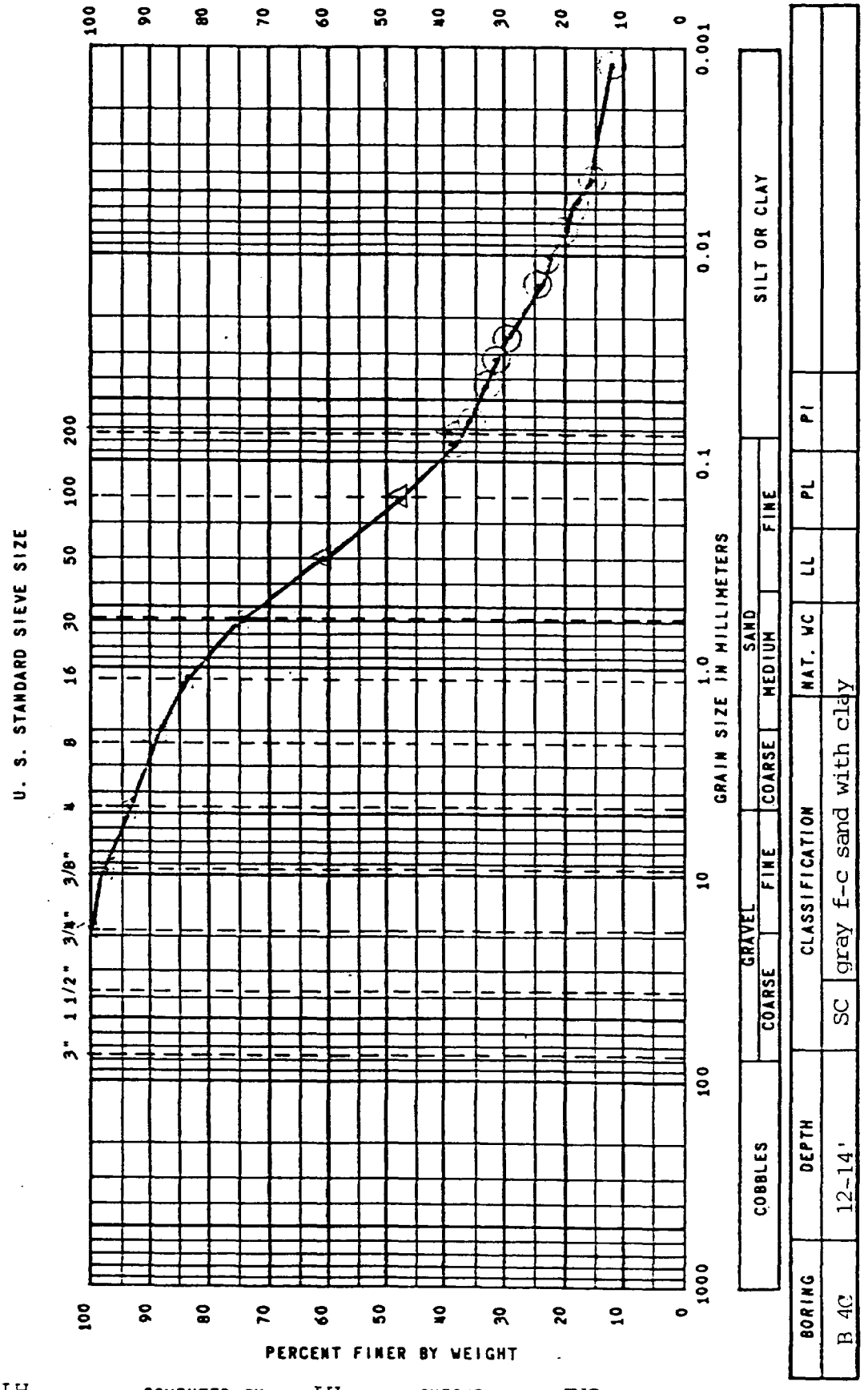
REMARKS

GRADATION CURVE

DATE 7/25/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 4C SAMPLE NUMBER 93002



TECHNICIAN LH COMPUTED BY LH CHECKED BY JNS

REMARKS

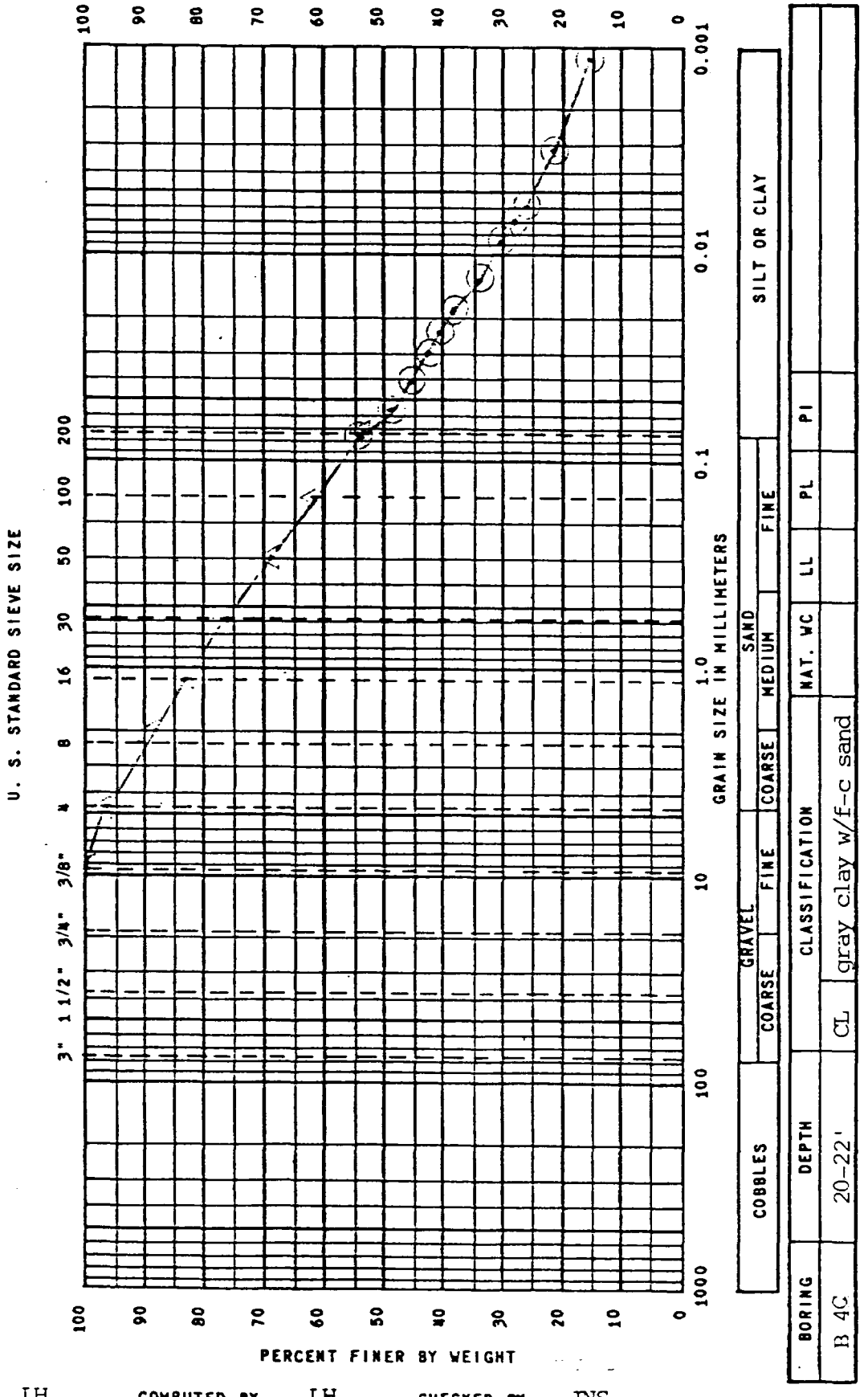
Materials Testing Consultants

GRADATION CURVE

DATE 7/25/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 4C SAMPLE NUMBER 93004



TECHNICIAN LH COMPUTED BY LH CHECKED BY JNS

REMARKS

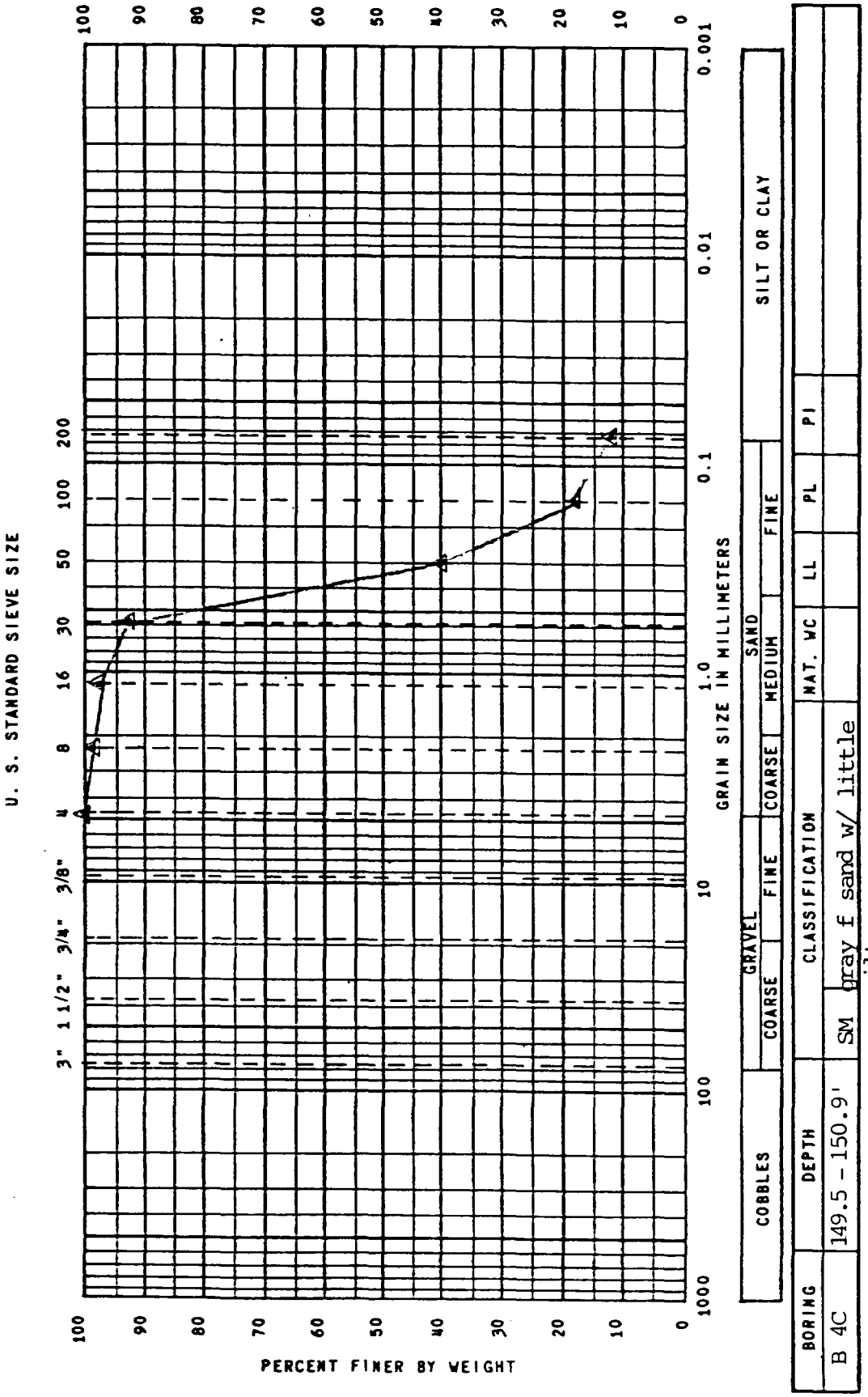
Materials Testing Consultants

GRADATION CURVE

DATE 7/11/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 4C SAMPLE NUMBER 92915



TECHNICIAN LH & GT COMPUTED BY LH CHECKED BY JNS

REMARKS

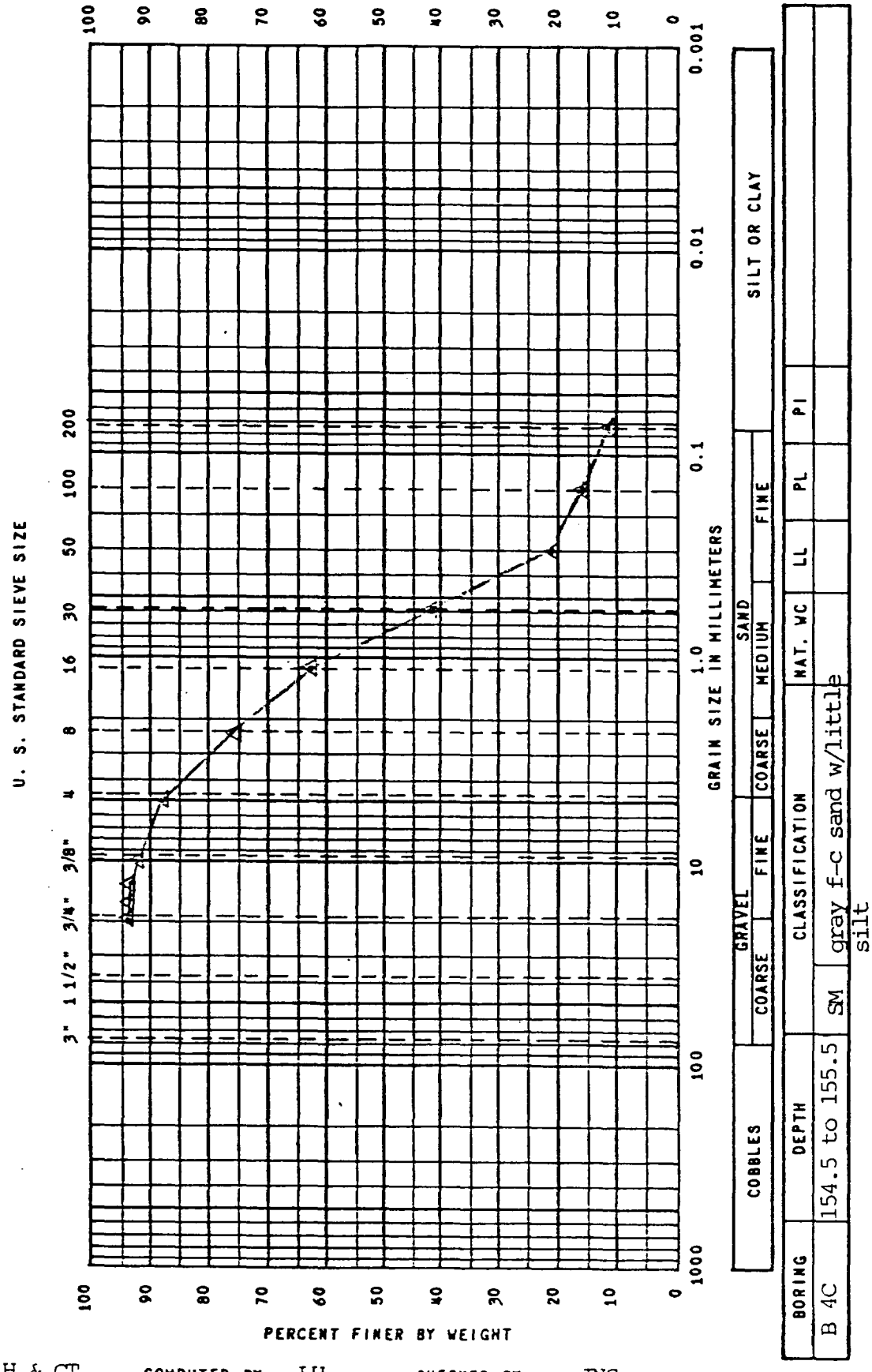
Materials Testing Consultants

GRADATION CURVE

DATE 7/11/83

CLIENT CH2M HILL PROJECT Zionsville, Michigan

JOB NUMBER 162G BORING NUMBER B 4C SAMPLE NUMBER 92916



BORING	DEPTH	CLASSIFICATION	NAT. WC	LL	PL	PI
B 4C	154.5 to 155.5	SM gray f-c sand w/little silt				

TECHNICIAN LH & GT COMPUTED BY LH CHECKED BY JNS

REMARKS

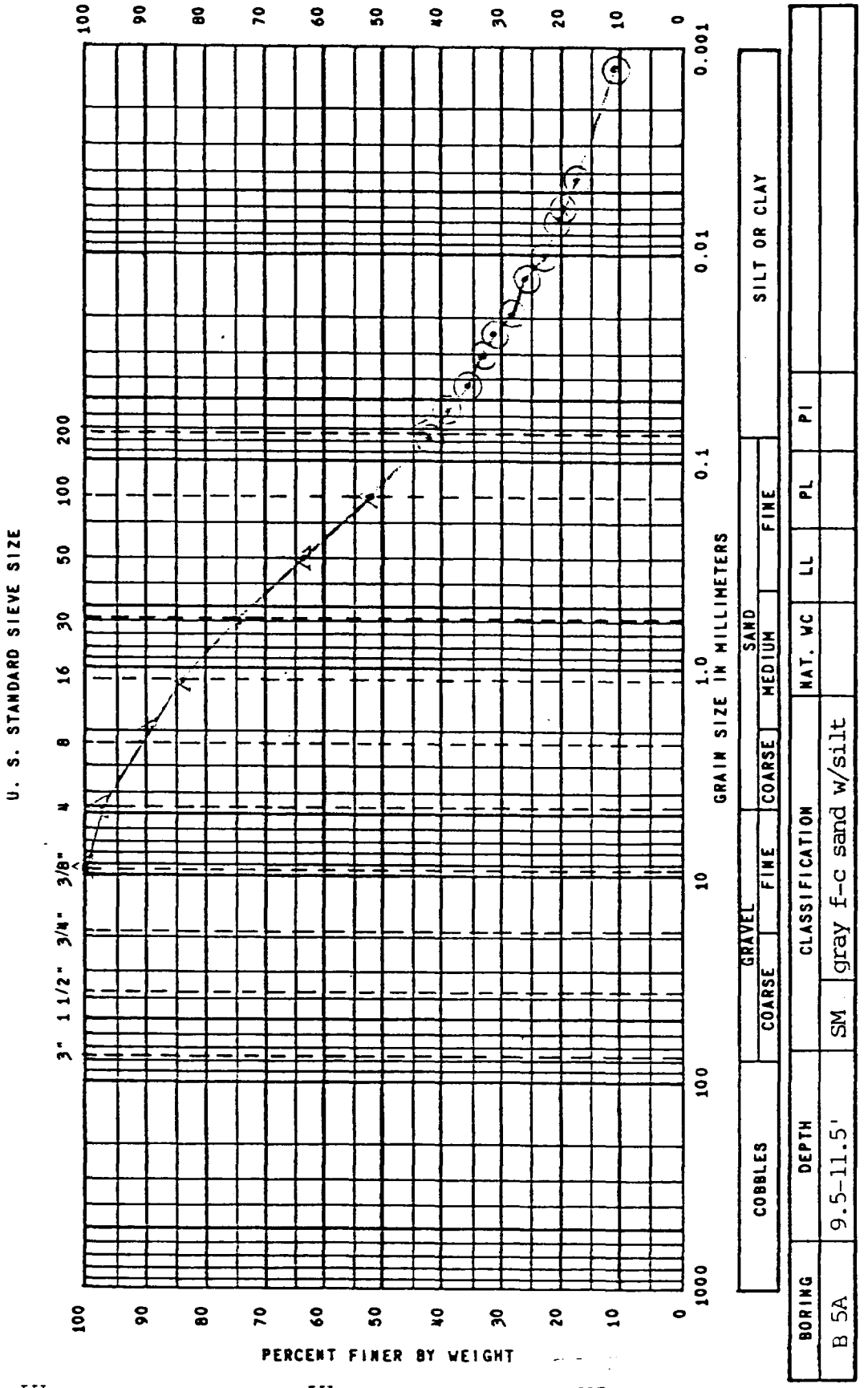
Materials Testing Consultants

GRADATION CURVE

DATE 7/25/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 5A SAMPLE NUMBER 92917



TECHNICIAN LH COMPUTED BY LH CHECKED BY JNS

REMARKS

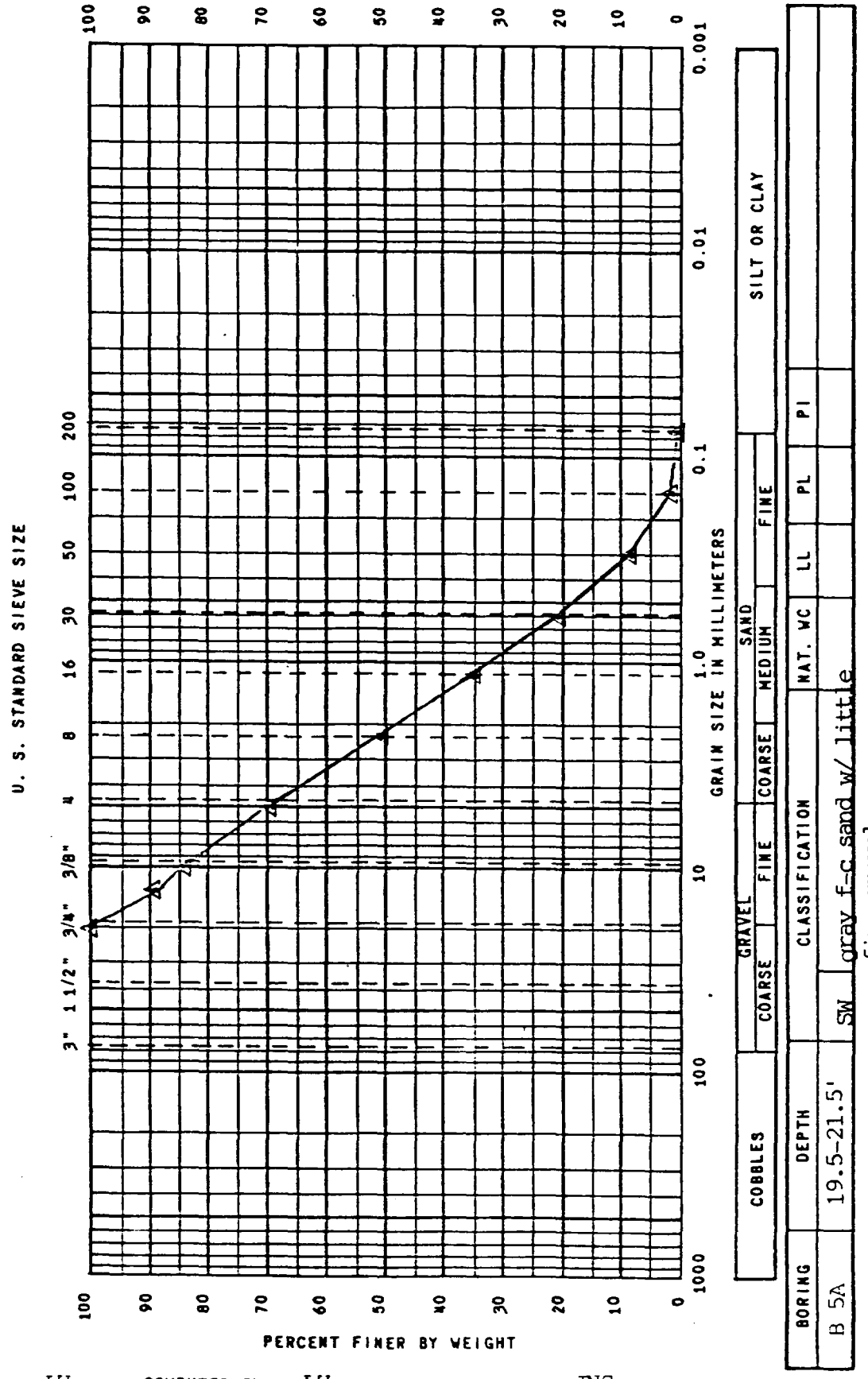
Materials Testing Consultants

GRADATION CURVE

DATE 7/8/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 5A SAMPLE NUMBER 92918



TECHNICIAN LH COMPUTED BY LH CHECKED BY JNS

REMARKS

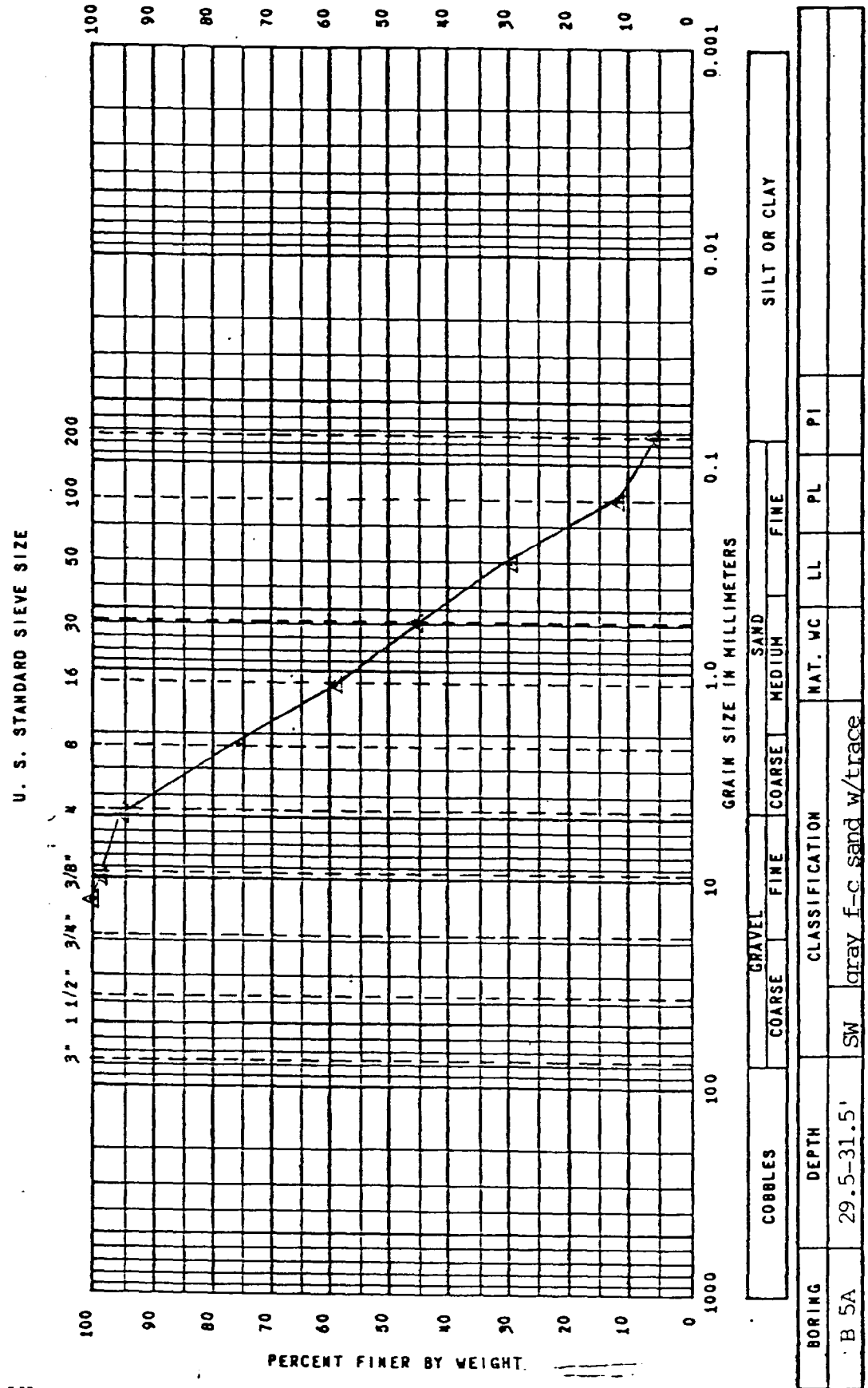
Materials Testing Consultants

GRADATION CURVE

DATE 7/8/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 5A SAMPLE NUMBER 92919



TECHNICIAN LH COMPUTED BY LH CHECKED BY JNS

REMARKS

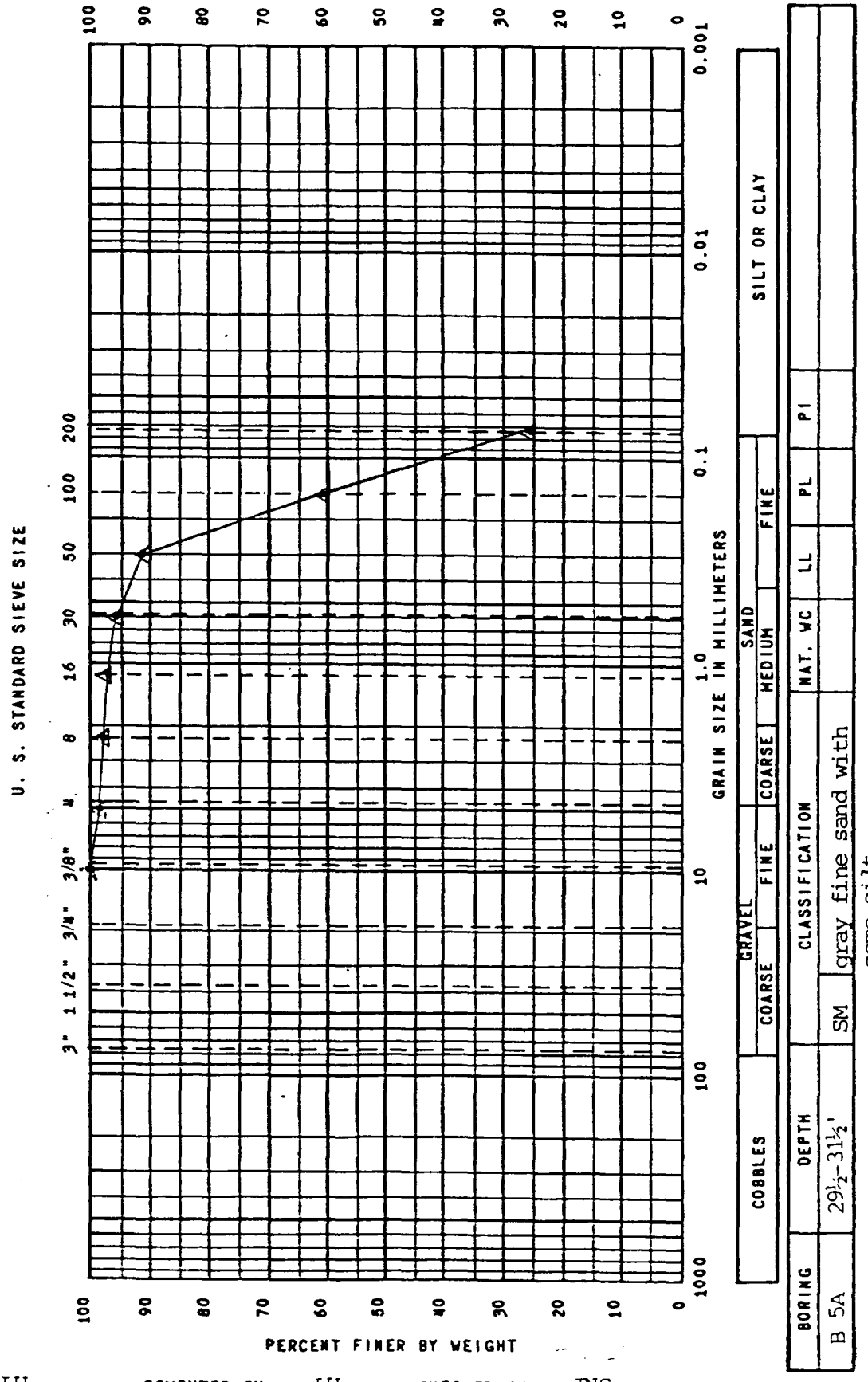
Materials Testing Consultants

GRADATION CURVE

DATE 7/25/83

CLIENT CH2M HILL PROJECT Zionsville, Indiana

JOB NUMBER 162G BORING NUMBER B 5A SAMPLE NUMBER 92920



TECHNICIAN LH COMPUTED BY LH CHECKED BY JNS

REMARKS

Materials Testing Consultants